Biological Survey of Bent's Old Fort National Historic Site, Otero County, Colorado

Report Submitted to the National Park Service
by the
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EXECUTIVE SUMMARY

During the summer of 2001, the Colorado Natural Heritage Program (CNHP) conducted inventories of vertebrates and vascular plants at the Bent's Old Fort National Historic Site. Those inventories were conducted in accordance with the guidelines described in *Study Plan for Biological Inventories in the Southern Plains Network of the National Park Service* (CNHP 2000). Previous biological inventories at BEOL had targeted and documented upland vascular plants but very few inventories had considered vertebrate species or the characteristics of the on site wetlands. Therefore, the study plan for BEOL called for the inventory of vertebrates in all areas of the site and inventory of vascular plants in the on-site wetlands only.

The funding available for the inventories limited the vertebrate field inventory to twelve days and the wetland vascular plant inventory to three days. While wetland vascular plant inventories are believed to have captured at least 90% of all species present on the site, the vertebrate inventories were unable to reach the 90% level due to the nature of vertebrate inventories and limited field time available within the budget. It should be emphasized, however, that National Park Service staff and volunteers could add substantively to the list of vertebrates documented at BEOL without the use of specialized sampling techniques. For example, simply by finding and vouchering animal carcasses, skulls, tracks, scats, and other sign, NPS workers could easily add many vertebrate species to the existing list. Over a period of years, a concerted effort of this type could gradually document the presence of many of the more elusive vertebrate species at BEOL.

The vertebrate inventory included birds, amphibians and reptiles, fish, and mammals Sampling techniques included the use of live traps, pitfall traps, coverboards, dip nets, seine nets, fixed-point auditory surveys (using playback of recordings of animal vocalizations), and visual encounter surveys (VES). Some methods were species-specific (e.g., fixed-point auditory surveys), whereas others targeted broader taxonomic groups (e.g., VES).

The vertebrate surveys documented 79 species on the BEOL master list (207 species) that previously had not been documented. The surveys also documented 7 species not previously included on the BEOL master list (six birds and one snake). Due to the inherent challenges of vertebrate surveying, additional survey effort will be required to document 90% of the species on the BEOL master vertebrate list.

The wetland vascular plant inventories targeted plants within the seven wetlands located on the BEOL site. These include four located on the north side of the Arkansas River (Arch wetland, Borrow pond, Day pond, Case Bolt wetland) and three on the south side(tamarisk pile near two-track road, abandoned slough, cattail pond). The surveys were conducted using opportunistic natural history survey methods.

The surveys of the BEOL wetlands documented 41 species present in the seven wetland areas. The master plant list for BEOL included 39 of the species found in the wetlands. Two common species had not previously been documented at BEOL and were added to the BEOL herbarium and master list. A total of fifteen wetland plant specimens were sent to the BEOL herbarium for permanent archival.

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SECTION I. VERTEBRATE SURVEY

INTRODUCTION

This report presents the results of a twelve-day field survey of the vertebrate fauna of Bent's Old Fort National Historic Site (BEOL) in Otero County, Colorado. A survey of such short duration, of course, could not possibly locate and identify all of the vertebrate species present on a site as large and diverse as BEOL. Many species are present at BEOL only seasonally (e.g., migratory birds); others may be present throughout the year but are active and detectable only seasonally (amphibians and reptiles). Some species are difficult to detect because they are nocturnal, secretive, trap-shy, and/or present in very low densities (e.g., mammalian carnivores).

The methods used during the August, 2001 field survey are described in this report, and recommendations are presented for the use of additional field techniques for the sampling of vertebrates at BEOL. It should be emphasized, however, that National Park Service staff and volunteers could add substantively to the list of vertebrates documented at BEOL without the use of specialized sampling techniques. For example, simply by finding and vouchering animal carcasses, skulls, tracks, scats, and other sign, park service workers could probably add many vertebrate species to the existing list. Over a period of years, a concerted effort of this type could gradually document the presence of many of the more elusive vertebrate species at BEOL.

METHODS

Field sampling for vertebrates occurred from August 6-18, 2001. Sampling techniques included the use of live traps, pitfall traps, coverboards, dip nets, seine nets, fixed-point auditory surveys (using playback of recordings of animal vocalizations), and visual encounter surveys (VES). Some methods were species-specific (e.g., fixed-point auditory surveys), whereas others targeted broader taxonomic groups (e.g., VES).

Eight trapping array stations were established on the Bent's Old Fort National Historic Site property. These stations were placed in various habitat types on both sides of the Arkansas River. Each trapping array consisted of 13 live traps and 5 pitfall traps. Live traps included six small (7.6 x 8.9 x 22.9 cm) Sherman traps, five large (7.6 x 8.3 x 30.5 cm) Sherman traps, one small (12.7 x 12.7 x 40.6 cm) Tomahawk trap, and one large (22.9 x 22.9 x 66.0 cm) Tomahawk trap. Sherman traps were baited with wild oats; Tomahawk traps were baited with various combinations of apples, carrots, raw meat (beef), canned dog food, and canned tuna. Pitfall traps consisted of unbaited metal cans (15.2 cm diameter x 17.8 cm deep) set at 1.0-meter intervals in a row at the center of the trapping array. On each side of the row of pitfall traps was a parallel row of Sherman traps (small Sherman traps on one side and large Sherman traps on the other). Sherman traps were placed at intervals of 5 meters. Tomahawk traps were set within 25 meters of the center of the trapping array. All traps were set and baited late each evening and then checked and closed early the next morning. To maximize trapping success, we opened and baited all traps the first evening they were placed in the field, rather than locking unbaited traps open for several days to acclimate animals to the presence of the traps.

During the second week of fieldwork, we placed 105 additional small Sherman traps in six widely-scattered habitat patches at BEOL in an effort to increase the number of small mammalian species that we captured. Habitat patches were specifically selected because they provided habitat suitable for use by mammalian species that we had expected to encounter but had not yet observed at BEOL. These traps, like the others, were set and baited late each evening and checked and closed early each morning.

A gradual but significant rise in the water level at the Arch Wetland slowly inundated the Sherman and Tomahawk live traps, forcing a relocation of this trap array. During the morning of August 14 we moved these 13 traps to an open grassland habitat located on the south side of the Arkansas River where they were deployed for the remaining four nights of trapping.

A coverboard station was located 50-100 meters from each of the 8 trapping arrays. Each station consisted of four coverboards placed within 6 meters of a central point. At each station, two coverboards were made of plywood (0.6 x 61.0 x 121.9 cm) and two were made of galvanized sheet metal (61.0 x 91.4 cm). Coverboards were placed flat on the ground and were not propped up. Irregularities in the ground surface created spaces where small animals could seek shelter beneath the coverboards. Each day, all coverboards were checked at least twice (morning and evening) for occupancy by small animals.

Fishes were sampled by direct observation and with dip nets and seine nets. Sampling of fishes occurred only at Day Pond and the Arch Wetland.

Mist nets were used to sample bats at Day Pond, where the shape and depth of the pond severely limited the placement of nets. Conditions at the Arch Wetland, especially the lack of open water (not covered with algae or cattails) and the lack of suitable sites for placing the mist-net poles, precluded successful sampling of bats with mist nets.

Visual encounter surveys were conducted on foot or by driving a motor vehicle slowly along existing roads while carefully scanning all visible habitats for vertebrates. Both types of surveys consisted of systematic searches of selected areas for prescribed periods of time. Foot surveys enabled us to sample relatively inaccessible (by road) portions of the BEOL property and areas with relatively dense vegetation. Foot surveys also were used to search for vertebrates in relatively open, accessible areas. Diurnal visual encounter surveys conducted along roads from a motor vehicle enabled us to quickly and repeatedly sample large areas of open habitat. Night road surveys during which search efforts for reptiles and amphibians were concentrated along the roads (because of darkness) also were considered visual encounter surveys.

In some cases, visual encounter surveys (by foot and vehicle) involved simultaneous searches for mammals, birds, reptiles, and amphibians. In other cases, visual encounter surveys targeted specific taxa, e.g., birds or reptiles. During visual encounter surveys, all visible habitat strata (e.g., ground surface, brush piles, understory, tree trunks and canopies, sky) were carefully searched. Brush piles of two types (cut tamarisk [*Tamarix ramosissima*] and flood-deposited woody debris) were extremely numerous, especially (but not only) near the Arkansas River. These brush piles were probed and examined carefully during foot surveys for reptiles and other vertebrates.

Fixed-point auditory surveys (involving playback of audio recordings of anuran and avian vocalizations) were done with a Sony portable CD player (model CFDS26). Anuran recordings

were used near Day Pond and the Arch Wetland during evenings after dark. Avian recordings were used during the day in all habitats.

All captured animals were examined, identified, and released at the capture sites. Voucher photographs were taken each time a new species was captured or observed. For each photograph, the species, date, and location were recorded in a field notebook and later transcribed to a computerized photograph log (Appendix IX).

Locations of trap arrays, coverboard stations, animal captures, and animal observations were recorded in a field notebook. Locations were determined using a Garmin 12 GPS (global positioning system) unit and were recorded as UTM (universal transverse mercator) coordinates. All coordinates were collected in the UTM projection, zone 13, North American Datum of 1927 (NAD27). A digital photograph was taken at each trapping array and at each coverboard station site. For each photograph, the subject, date, and location were recorded in a field notebook and later transcribed to a computerized photograph log (Appendix X).

RESULTS AND DISCUSSION

Quantified Description and Location of Search Effort and Areas

During 12 nights of trapping, we used live traps of 4 different sizes (see Methods for trap dimensions) to capture small and medium-sized mammals. Trapping effort was measured as the number of trap nights (1 trap night = 1 open trap present in the field for 1 night) for each type and size of trap (Table I).

Table I. Live-trapping effort for small and medium-sized mammals at BEOL, August 2001.

Trap Type	Trap Size	Trapping Effort (No. of Trap Nights)
Sherman	small	841
Sherman	large	460
Tomahawk	small	92
Tomahawk	large	89

Selection of the specific field locations for the 8 trap arrays (each array consisted of 13 traps of specified types and sizes as described in the Methods section) and coverboard stations was based on the desire to maximize trapping coverage of the various types of habitats available at BEOL and also maximize the number of mammalian species captured and documented (Table II).

Table II. Locations of eight trap arrays and associated coverboard stations at BEOL, August 2001.

Trap Array Number	Description	Live Traps UTM (easting)	Live Traps UTM (northing)	Coverboards UTM (easting)	Coverboards UTM (northing)
1	general upland to west of fort	0637477	4211037	0637417	4210966
2	Casebolt Wetland	0637376	4210738	0637371	4210560
3	floodplain to east of fort	0638060	4211185	0638077	4211262
4a	Arch Wetland	0638076	4211708	0638144	4211549
4b[1]	revegetated "old field" habitat	0638884	4211017	0638144	4211549
5	tamarisk invasion zone to north of river	0638339	4211026	0638253	4211090
6	tamarisk invasion zone to south of river	0637816	4210563	0637757	4210461
7	tamarisk invasion zone to south of Arkansas River	0638323	4211944	0638384	4212046
8	willows along shore of Arkansas River	0638199	4210855	0638110	4210873

[1]Elevation of the water table at the Arch Wetland forced a relocation of trap array 4 on August 14 to a revegetated grassland habitat on the south side of the Arkansas River. The trap array was moved from location 4a to location 4b.

Small Sherman live traps also were placed in selected locations to target small mammals in specific habitats (Table III).

Table III. Additional locations of small Sherman live traps at BEOL, August 2001.

Habitat Type	No. of Traps	No. of Nights Trapped	UTM (easting)	UTM (northing)
sand sage shrubland	2-3	5	0638470	4210806
sand sage shrubland	25	3	0638464	4210744
sand sage shrubland	10	3	0638704	4211502
sand deposits along river	15	3	0637407	4210447
revegetated upland	15	3	0637406	4210995
in and around maintenance buildings	20	2	0637428	4211700
sand sage shrubland	20	2	0638682	4211068

To quantify the search effort for mammals of various body sizes, we defined small, medium, and large mammals on the basis of body mass (small mammals $\leq$ 400 g. < medium-sized mammals $\leq$ 50 kg. < large mammals). Thus, medium-sized mammals included the Virginia opossum (scientific names of vertebrates are given in Appendices I-VIII), nine-banded armadillo, rock and fox squirrels, black-tailed prairie dog, lagomorphs, American beaver, raccoon, common porcupine, common muskrat, bobcat, and the canids and mustelids (weasel family). Large mammals consisted of the mountain lion, black bear, pronghorn, and cervids (deer and elk).

Efforts to document the presence of small mammals at BEOL consisted solely of live trapping, and so search effort was expressed as the number of trap nights that targeted the capture of small mammals. Small mammals were captured in small and large Sherman traps and in small Tomahawk

traps, and so the numbers of trap nights for all three of these trap types/sizes were combined to calculate small mammal search effort (1,393 trap nights) (Table I).

Efforts to document the presence of medium-sized mammals included live trapping and visual encounter surveys (VES). Medium-sized mammals were captured in small and in large Tomahawk traps, so we quantified the live-trapping search effort for medium-sized mammals by summing the numbers of trap nights for these two trap sizes (181 trap nights). The search effort for medium-sized mammals during VES was expressed as the number of hours (29.5) spent searching (Table IV).

The presence of birds, amphibians, reptiles, and large mammals at BEOL also was determined through the use of VES. Accordingly, the search effort for each of these vertebrate groups was quantified as the number of hours spent searching for these animals (Table IV).

Table IV. Search effort for vertebrates during visual encounter surveys (VES) at BEOL, August 2001.

Vertebrate Group	Search Effort (Hours of VES)
Birds	55.0
Amphibians	61.0
Reptiles	61.0
Medium-sized mammals[1]	29.5
large mammals[2]	29.5

[1] body mass 400 g. to 50 kg.
[2] body mass > 50 kg.

Fishes were sampled by dip netting and by seine netting at Day Pond and in areas of open water at the Arch Wetland. Search effort for fishes consisted of 8.0 hours spent dip- and seine netting at these locations (Table V). Bats were sampled after dark at Day Pond with mist nets, and bat sampling effort included 9.0 hours of mist-netting activity during three evenings.

Table V. Search effort for fishes at BEOL, August 2001.

Sampling Method	Search Effort (Hours)	
	Day Pond	Arch Wetland
dip netting	3.75	1.75
seine netting	2.0	0.5

Amphibians and reptiles also were sampled through the use of artificial cover (coverboards). Five coverboard stations (each consisting of 2 plywood and 2 sheet metal coverboards) were set up on August 6, and the remaining 3 stations were established on August 7. Two coverboards (1 plywood and 1 sheet metal) at one of the stations were inadvertently removed from the field on August 9 by National Park Service personnel who mistook the coverboards for trash. These boards were replaced at their field locations on August 11. All coverboards were checked at least twice daily (morning and evening) to determine if amphibians and reptiles were using them for cover. All coverboards were permanently removed from the field during the evening of August 17. If the presence of one coverboard in the field for one 24-hour day is considered a "coverboard day" then our coverboard sampling effort for amphibians and reptiles consisted of 336 coverboard days. No amphibians or reptiles were found beneath coverboards at BEOL. This result was not surprising for several

reasons. First, natural cover was readily available to reptiles in the form of numerous piles of cut tamarisk trees and flood-deposited piles of woody debris. In addition, our coverboards were placed in the field on the first day of fieldwork. It is generally recommended that coverboards be deployed several months prior to the onset of fieldwork so that they can "weather" and so that animals can acclimate to their presence. Finally, amphibians tend to seek shelter beneath coverboards during wetter times of the year (Heyer et al. 1994), and our field survey occurred during dry weather in August.

Pitfall traps also were used to sample amphibians, reptiles, and small mammals. Five pitfall traps were placed at each of the 8 trapping arrays (5 arrays were established on August 6 and 3 were established on August 7), and these pitfall traps were checked at least twice daily (morning and evening). All pitfall traps were removed from the field during the evening of August 17. If the presence of one pitfall trap in the field for one 24-hour day is considered a "pitfall trap day" then our pitfall sampling effort for amphibians, reptiles, and small mammals consisted of 425 pitfall trap days. One amphibian (an adult plains leopard frog), one reptile (a juvenile six-lined racerunner), and no small mammals were captured in pitfall traps at BEOL.

Fixed-point auditory surveys were conducted on 3 nights (0.75 hours per night) at Day Pond and at the Arch Wetland to sample breeding anurans. Recorded vocalizations of the following species were played back: bullfrog, plains leopard frog, northern leopard frog, western chorus frog, plains spadefoot, and Woodhouse's toad. In response to the playback of the recordings we heard the calls of a lone male bullfrog at Day Pond and another lone male bullfrog at the Arch Wetland. Although Woodhouse's toads were known to be present and active at BEOL during our survey, no vocalizations of Woodhouse's toads were heard during our fixed-point auditory anuran surveys. It is common, however, for male anurans to stop calling after seasonal breeding activities have been completed (Duellman and Trueb 1986, Karns 1986, Zug 1993, Stebbins and Cohen 1995).

Analysis of Survey Results Compared to Master Species List

Birds

The breeding bird master species list for BEOL included 92 avian species, 46 of which were documented during our field survey in August 2001. In addition, we documented the presence of 6 species at BEOL that were not included on the breeding bird master species list.

There are several reasons why the field survey did not detect all 92 avian species included on the master list. For example, many of the species on the master list may occur in the general vicinity of BEOL but they do not inhabit BEOL because suitable habitat is not available at the site. Other avian species that were included on the master list probably breed at BEOL in the spring and then leave the immediate area after their young have fledged. Survey work conducted in August, after the departure of these birds, would not detect such species. The master species list included species that are present at BEOL only during their seasonal migratory movements through the area. These migrants would not be detected unless their passage through the BEOL area happened to coincide with the timing of the zoological survey work. Finally, the master species list also included several species that are considered uncommon to rare, and these species would not likely be detected due to their extremely low population densities.

Examples of avian species that breed in the region surrounding BEOL but probably do not breed on the BEOL property due to lack of suitable habitat would include the American White Pelican, Snowy Plover, Black-necked Stilt, American Avocet, Ring-billed Gull, and Least Tern. These species require habitats such as large reservoirs, lakes, or ponds with adjacent alkaline flats (Andrews and Righter 1992) that are not available at BEOL. Several other species have specific habitat requirements that are not met at BEOL, such as the Mountain Plover (Knopf and Miller 1994) and Burrowing Owl (Haug et al. 1993) (both species require flat, open areas with very low-growing vegetation), and Curve-billed Thrasher (which prefers cholla grasslands and open pinyon-juniper woodlands) (Andrews and Righter 1992).

Avian species that seasonally migrate through the BEOL area (and breed elsewhere) include the Great Crested Flycatcher, Violet-green Swallow, Sage Thrasher, Brewer's Sparrow, and McCown's Longspur. These species were included on the breeding bird master list but would not really be expected to occur at BEOL except as seasonal migrants (Andrews and Righter 1992; also see Kingery 1998).

Several species that were included on the breeding bird master list for BEOL are considered uncommon or rare on the southeastern plains of Colorado. The Golden Eagle, Prairie Falcon, Belted Kingfisher, Canyon Towhee, and Long-billed Curlew are examples of such species; they occur in very low densities in southeastern Colorado (Andrews and Righter 1992) and therefore the likelihood of our observing them at BEOL during a 12-day survey in August was low.

Six avian species that were not included on the breeding bird master list were documented at BEOL during the field survey. Wild Turkeys, released (reintroduced) onto lands adjacent to BEOL by the Colorado Division of Wildlife, were frequently seen (both adults and young) on BEOL property on both sides of the Arkansas River during the field survey. Yellow-billed Cuckoos were observed flying and foraging in pairs, suggesting that these birds may have bred at BEOL. Observations of lone Blue Jays also were common at BEOL during the survey, but flocks of Blue Jays were not seen. Downy Woodpeckers were seen (singly) on several occasions as they foraged in the trees in the cottonwood riparian woodland along the Arkansas River. Two observations were made of Green Herons that were flying or loafing along the shoreline of the Arkansas River. Lastly, a small flock of migrating Chipping Sparrows was seen in an open grassland habitat located to the west of the fort and to the north of the Arkansas River and the Casebolt Wetland.

Mammals

The mammal master species list for BEOL included 55 species, 20 of which were documented during the field survey. For several reasons, however, many of the species on the master list were not expected to be found at BEOL. For example, the master list included several species (e.g., black-footed ferret, American elk) whose presence as free-ranging animals in the vicinity of BEOL has not been documented for many years (Warren 1910, Armstrong 1972, Fitzgerald et al. 1994). In the case of the nine-banded armadillo, no breeding populations have ever been reported in Colorado (Fitzgerald et al. 1994). In addition, many species on the master list are carnivores (order Carnivora) that typically occur in very low densities and are rarely seen due to their cautious and secretive (and often nocturnal) behavior. A characteristic of such species is the tendency for individual animals to range widely over large geographical areas. Members of the bear (black bear), weasel (long-tailed weasel, mink, American badger, eastern spotted skunk, striped skunk, common hog-nosed skunk) cat (mountain lion, bobcat), and dog (red fox, swift fox, gray fox) families are examples. Budgetary

limitations forced our reliance on live trapping and on visual encounter surveys to detect the presence of these carnivores. The use of baited tracking plate stations equipped with automatic cameras (a very costly technique) probably would have been a much more successful means of documenting the presence of these wide-ranging, elusive mammals.

Several mammalian species that are included on the master species list probably do not occur at BEOL because an adequate amount of suitable habitat is not available. Pronghorns, for example, require vast expanses of open habitat with low-growing vegetation (Yoakum 1972, Sundstrom et al. 1973); only small patches of such habitat are available at BEOL. Similarly, the rock squirrel typically inhabits rocky hillsides and canyons where it requires boulders, talus, rock outcrops, or similar habitat features (Howell 1938, Armstrong 1972, Findley et al. 1975) that are unavailable at BEOL. Plains pocket mice and silky pocket mice prefer grassland habitats with sandy soils (Best and Skupski 1994, Fitzgerald et al. 1994, Monk and Jones 1996) that are available only as small patches at BEOL. Moreover, silky pocket mice are scarce over most of their range and may be difficult to trap (Fitzgerald et al. 1994). Other mammalian species for which sufficient appropriate habitat is not available at BEOL include the Mexican woodrat (prefers rocky slopes and cliffs), southern plains woodrat (prefers grasslands with prickly pear and cholla cacti), and the pinyon mouse (inhabits pinyon-juniper woodlands) (Hoffmeister 1951, 1981; Finley 1958, Fitzgerald et al. 1994).

Bats are often sampled by capturing them with mist nets as they fly slightly above the surface of the water (as they drink) at ponds or other bodies of open water (Kunz and Kurta 1988, Thomas and West 1989). At the Arch Wetland, cattails and surface vegetation severely limited bats' access to open water, so we set up mist nets at Day Pond, where flight paths over open water were more readily available to the bats. Unfortunately, environmental conditions were suboptimal during the 3 evenings when we tried to sample bats. Excessive wind and moonlight increased the visibility of the mist nets and enabled bats to detect the nets. We watched many bats avoid the mist nets by altering their flight paths just as they reached the nets. Bats surely forage and drink at BEOL, and they may roost there (in tree cavities, under the bark of trees, in crevices in the ground, under loose rocks, and in the fort and maintenance buildings). Additional sampling will be needed, under better field conditions, to determine the identity of the bat species present at BEOL.

Amphibians

Eleven species of amphibians were included on the amphibian master species list for BEOL, and the presence of three of these species was documented during the field survey. The master list included one salamander and ten anuran species.

Tiger salamanders breed in temporary or permanent bodies of water but they rarely use sites with predatory fishes because such fishes consume salamander eggs and larvae (Blair 1951, Woodbury 1952, Brandon and Bremer 1967, Hammerson 1999). In some locations, fish absence is the most important factor influencing the presence of tiger salamanders (Geraghty and Willey 1992). Potential breeding habitat at BEOL includes Day Pond and the Arch Wetland, but the presence of predatory fishes (e.g., green sunfish) at these sites probably precludes successful reproduction by salamanders.

The three species of spadefoots ("spadefoot toads") that are included on the master list may be present at BEOL, but the timing of the field survey did not coincide with the period of intense

breeding activity that characterizes these species. Although spadefoots typically are active in eastern Colorado from May until September or early October, their breeding often is limited to May, June, and sometimes July (Hammerson 1999). Spadefoots are inactive for most of the year, when they remain buried in the soil. Heavy spring and summer rains stimulate the spadefoots to awaken, dig to the soil's surface, and breed in temporary pools of water formed by the rains. After breeding, adults disperse from breeding pools and seek shelter underground when not actively foraging. Development of spadefoot eggs and larvae is extremely rapid as an adaptation to the ephemeral nature of the breeding pools in which the young develop.

Conditions during the field survey in August 2001 generally were very dry. One brief rain event occurred during the 12-day survey, but the amount and duration of rainfall were relatively slight and we noticed no subsequent increase in activity by amphibians and reptiles at BEOL. The timing of the field survey (not coincident with the typical period of breeding activity by spadefoots) and the lack of significant rainfall during the survey period strongly influenced our ability to sample spadefoots at BEOL. A survey conducted during the May-June period of greatest reproductive activity would be more likely to detect the presence of spadefoots, although the importance of heavy rains as a stimulant to spadefoot activity cannot be overemphasized.

Three true toads (Bufonidae) were included on the amphibian master species list, and we documented the presence of one of these species (Woodhouse's toad). Red-spotted toads, which prefer rocky canyons (Stebbins 1954, Hammerson 1999), probably do not inhabit BEOL due to a lack of such habitat. Great Plains toads become active and reproduce in response to warm, heavy rains during spring and summer (Stebbins 1954, Hammerson 1999). The prevalence of very dry conditions during the August field survey probably caused this species (if present) and many other amphibian and reptilian species at BEOL to be relatively inactive and undetectable.

Three species of true frogs (Ranidae) and one species of tree frog (Hylidae) were included on the amphibian master species list. Two (bullfrog and plains leopard frog) of the three ranids were observed at BEOL, but the third, the northern leopard frog, was neither seen nor heard. The northern leopard frog has not been reported from Otero or Bent counties (Hammerson 1999), and it is possible that it does not occur at BEOL. The western chorus frog, a tree frog, usually breeds during April, May, and June on the eastern plains of Colorado and then becomes relatively inconspicuous for the remainder of the summer (Hammerson 1999). This species may have avoided detection during the field survey at BEOL because of its seasonally low activity level.

The colonization of BEOL by bullfrogs (which are native to eastern North America and introduced at many locations throughout western states) may have dire consequences for native anurans at the site. As larvae and as adults, bullfrogs may affect populations of other frogs through predation, competition, and the transmission of parasites or diseases. The establishment of introduced bullfrogs has been implicated as a cause of the declines of populations of native frogs at many sites in western North America (see Hammerson 1999:141 and references cited there).

Reptiles

Of the three species of turtles included on the master reptile species list, one (spiny softshell turtle) was observed at BEOL during the field survey. Ornate box turtles may be present at BEOL, where small patches of their preferred habitat (sandhills and shortgrass prairie) are available. The prevalence of very dry conditions, however, would have caused these turtles to remain relatively

inactive during the field survey. Ornate box turtle activity increases greatly after heavy rains (Degenhardt et al. 1996, Hammerson 1999). Although the western painted turtle occurs in the Arkansas River basin both upstream and downstream from BEOL, it has not been reported to occur in Otero County or near BEOL (Hammerson 1999). Expansion of this species' range in the recent past or in the future may enable it to colonize BEOL, but the lack of suitable basking sites in the wetlands at BEOL, and the possible lack of appropriate nesting sites, may preclude the successful establishment of a large number of western painted turtles at BEOL.

The field survey documented the presence of three of the seven lizard species that were included on the reptile master species list. We observed the Texas horned lizard, the six-lined racerunner, and the Great Plains skink at BEOL. It is likely that the lesser earless lizard and the short-horned lizard are present at BEOL but were not detected during the field survey. On the other hand, the collared lizard and the prairie lizard probably do not occur at BEOL because the rocky habitats they prefer (Hammerson 1999) are not available.

Two of the 14 species of snakes included on the reptile master species list were found at BEOL during the field survey. A road-killed bullsnake and two western rattlesnakes were observed. In addition, two plains garter snakes (a species that was not included on the reptile master species list) were observed at BEOL. Snakes are notoriously difficult to sample because of their reclusive behavior. Of the 12 master-listed snake species that we did not find at BEOL, 11 (all but the ground snake, which prefers habitats that are not available at BEOL, such as shale outcroppings, rocky canyons and other areas with numerous flat rocks [Degenhardt et al. 1996, Hammerson 1999]) are likely to occur there. During the survey we caught glimpses of two snakes that we could not identify with certainty. Both snakes were thought to be racers.

Fishes

Many of the 25 species of fish listed on the master species list prefer or usually occur in habitats quite different from those available at Day Pond and at the Arch Wetland (e.g., stoneroller, gizzard shad, Arkansas darter, red and sand shiners, longnose dace) (Minckley 1973, McClane 1978, Tomelleri and Eberle 1990, Page and Burr 1991, Cross and Collins 1995, Sigler and Sigler 1996). Fishes present in the Arkansas River at BEOL, however, could reach Day Pond and the Arch Wetland during flood events, and they may have done so in the past. Unfortunately, it is not known if such colonization events have led to the successful establishment of breeding populations of fishes at Day Pond or at the Arch Wetland.

Four species of fishes were documented at BEOL during the field survey. Plains killifish, mosquitofish, and green sunfish were captured in nets at both Day Pond and the Arch Wetland. A large common carp was observed at Day Pond. Additional species of fishes may have been present at Day Pond and at the Arch Wetland, but the sampling techniques that we used were not well-suited for the conditions at these sites. Therefore the field survey probably did not obtain a representative sample of the fish diversity present in the non-riverine wetlands at BEOL.

Analysis of Results Based on Species Accumulation by Effort Function

Birds

Visual Encounter Surveys - After an initial flurry of sightings of new species, the rate of detection of additional avian species decreased through the remainder of the field survey (Table VI, Fig. 1).

The investment of additional search effort continued to document the presence of more species, but the rate of acquisition of new species decreased noticeably. This pattern suggests that the field survey was successful in detecting most of the avian species that were present at BEOL in early to mid-August.

Table VI. BEOL birds: Species accumulation by effort (visual encounter surveys).

Search Effort (Hours)	No. of Species Documented
8	9
12	17
17	28
21	31
28.5	35
35.5	39
38.5	41
39.5	43
43.5	44
49.5	45
54	48
55	49

As noted earlier, some avian species that breed at BEOL may disperse from the area after their young have left the nest or are able to feed themselves. Such species might not be present at BEOL in August and therefore a field survey conducted in August might not detect them. For that reason, to properly sample the breeding birds of BEOL, it would be necessary to conduct field survey work during both the spring and the summer. Because our August survey "missed" the early-breeding birds at BEOL, it is recommended that additional sampling for breeding birds be conducted at BEOL during spring. surveys).

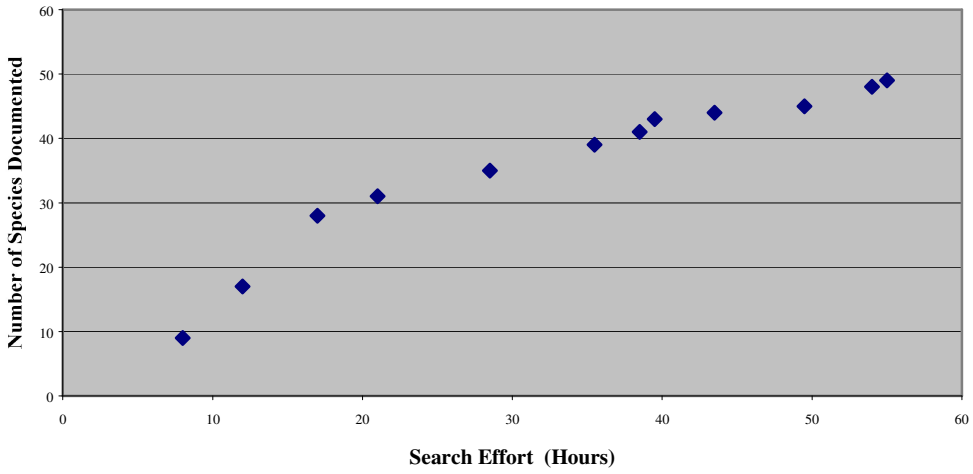

Figure 1. BEOL birds: Species accumulation by effort function (visual encounter surveys).

Small Mammals

Live Trapping - Live-trapping of small mammals was successful in confirming the presence at BEOL of most of the species on the master species list. The rate of discovery of new species declined throughout the period of the field survey (Table VII, Fig. 2). During the last few days of the field survey we targeted certain small mammal species that had not yet been captured (Ord's kangaroo rat, northern grasshopper mouse). Through intensive trapping in selected patches of appropriate habitat, we succeeded in catching these species. Additional live trapping, even in selected habitats, would have been unlikely to substantially add to the list of small mammalian species documented at BEOL. Plains and silky pocket mice are perhaps the only species that would have been found through extended live trapping.

Table VII. BEOL small mammals: Species accumulation by effort (live trapping).

Search Effort (Hours)	No. of Species Documented
60	2
156	4
252	4
351	5
450	5
548	6
646	6
734	6
895	6
1096	8
1297	9
1393	9

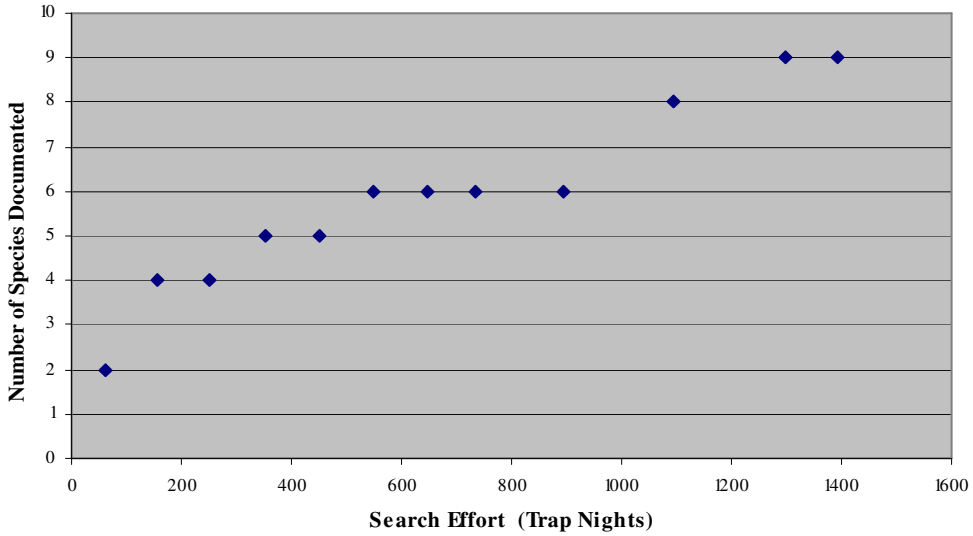

Figure 2. BEOL small mammals: Species accumulation by effort function (live trapping).

Medium-sized Mammals

Live Trapping - The low-intensity (181 trap nights) live trapping that we employed was not an efficient means of sampling medium-sized mammals at BEOL (Table VIII, Fig. 3). Although we used a variety of attractive baits (see Methods section) and although the Tomahawk traps often were visited and disturbed by mammals during the night, we captured only one species of medium-sized mammal (3 raccoons). Additional trapping (more trap nights) probably would have enabled us to capture more species of medium-sized mammals (e.g., striped skunk, a road-killed specimen of which was seen along Colorado Route 194 about 2 miles west of BEOL) but the rate of acquisition of new species would probably have been very slow.

Table VIII. BEOL medium-sized mammals: Species accumulation by effort (live trapping).

Search Effort (Trap Nights)	No. of Species Documented
10	0
26	0
42	1
57	1
73	1
89	1
105	1
119	1
135	1
151	1
166	1
181	1

As noted in the "Analysis of Survey Results Compared to Master Species List," many of the medium-sized mammalian species that are included on the master species list are carnivores (order Carnivora). These animals may be sampled with scented or baited track plate stations equipped with automatic camera systems (Wilson et al. 1996), the high cost of which precluded their use in our field survey.

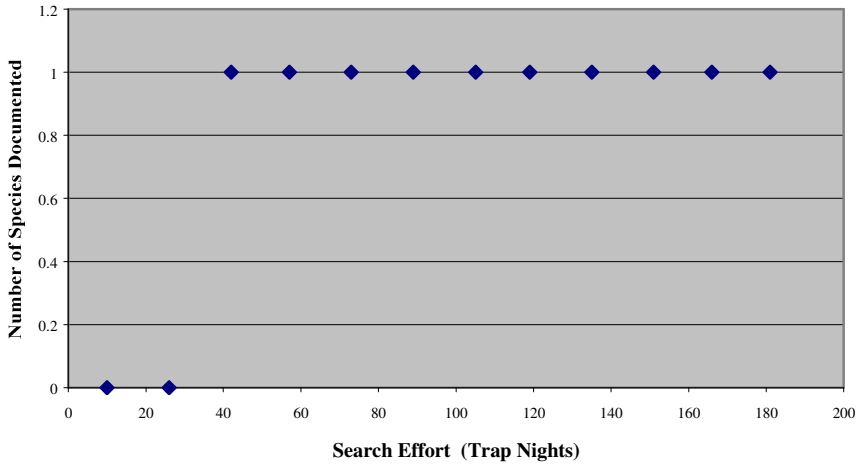

Figure 3. BEOL medium-sized mammals: Species accumulation by effort function (live trapping).

Visual encounter surveys - Visual encounter surveys documented the presence of 6 species of medium-sized mammals at BEOL. Four species were documented during the first six hours of survey work, but then the rate of sighting new species dropped precipitously (Table IX, Fig. 4). The investment of additional effort in visual encounter surveys for medium-sized mammals would probably yield new species because it is likely that there are at least several undetected species present at BEOL. Eventually some of these species would be discovered during additional visual encounter surveys. The efficiency of such efforts might be unacceptably low, however, because the rate of discovery of new species would probably be very slow.

Table IX. BEOL medium-sized mammals: Species accumulation by effort (visual encounter surveys).

Search Effort (Hours)	No. of Species Documented
6	4
11	4
14	4
18	4
24	5
28.5	6
29.5	6

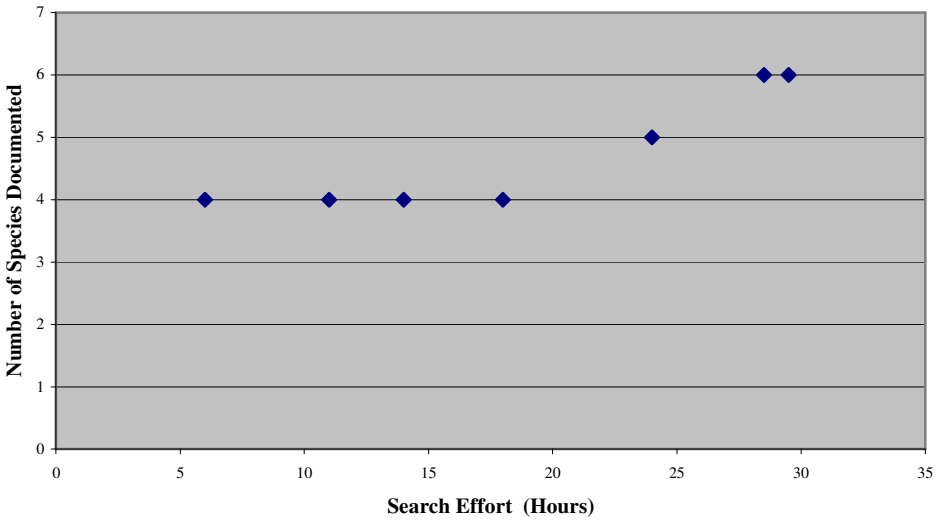

Figure 4. BEOL medium-sized mammals: Species accumulation by effort function (visual encounter surveys).

Large Mammals

Visual encounter surveys - Although six species of large mammals are included on the master species list, it is very likely that only two of those species, mule and white-tailed deer, occur at BEOL. We documented the presence of both species of deer during the first 11 hours of visual encounter surveys. The expenditure of an additional 18.5 hours of VES yielded no new species of large mammals (Table X, Fig. 5), but this result was not surprising. It is very unlikely that any of the other four species of large mammals that were listed on the master species list (mountain lion, black bear, elk, pronghorn) occur at BEOL. (Pronghorns are common on the native shortgrass prairie and on other grasslands throughout eastern Colorado (Fitzgerald et al. 1994) but sufficiently large patches of suitable habitat for these native ungulates are not available at BEOL.)

Table X. BEOL large mammals: Species accumulation by effort (visual encounter surveys).

Search Effort (Hours)	No. of Species Documented
6	1
11	2
14	2
18	2
24	2
28.5	2
29.5	2

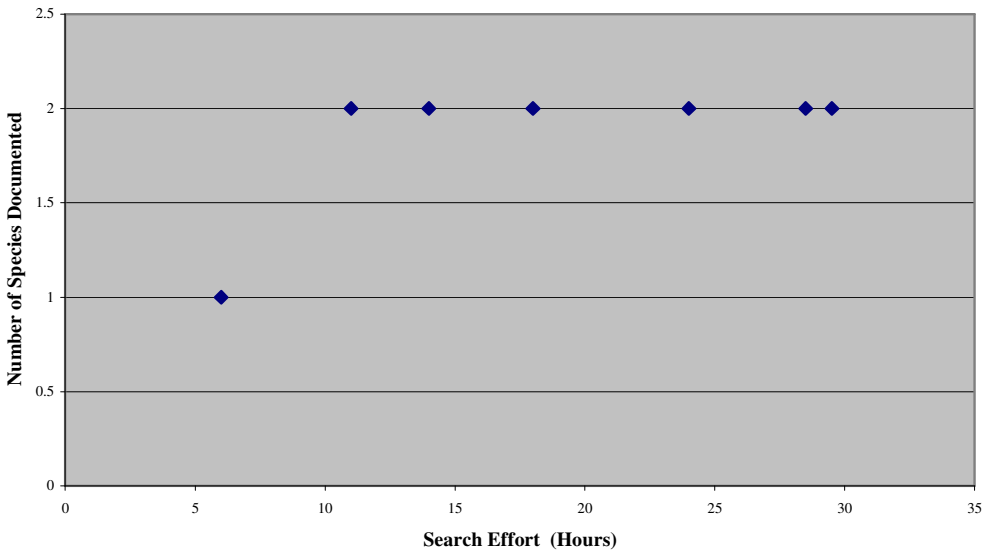

Figure 5. BEOL large mammals: Species accumulation by effort function (visual encounter surveys).

Amphibians

Visual Encounter Surveys - Although more than 60 hours of effort were devoted to visual encounter surveys for amphibians at BEOL, only three species of amphibians were observed (Table XI, Fig. 6). It is unlikely that the investment of additional time in VES for amphibians would have yielded observations of new species. The few amphibian species that may have been present but undetected were anurans that would have been very difficult to detect during dry weather in August. To properly assess amphibian biodiversity at BEOL it would be necessary to search appropriate habitats during the periods of intense breeding activity, which occur after heavy rains during the spring and early summer (Hammerson 1999).

Table XI. BEOL amphibians: Species accumulation by effort (visual encounter surveys).

Search Effort (Hours)	No. of Species Documented
1	0
4.5	1
7.5	1
12.5	2
20.5	2
30.5	3
37.5	3
43	3
49.5	3
55.5	3
60	3
61	3

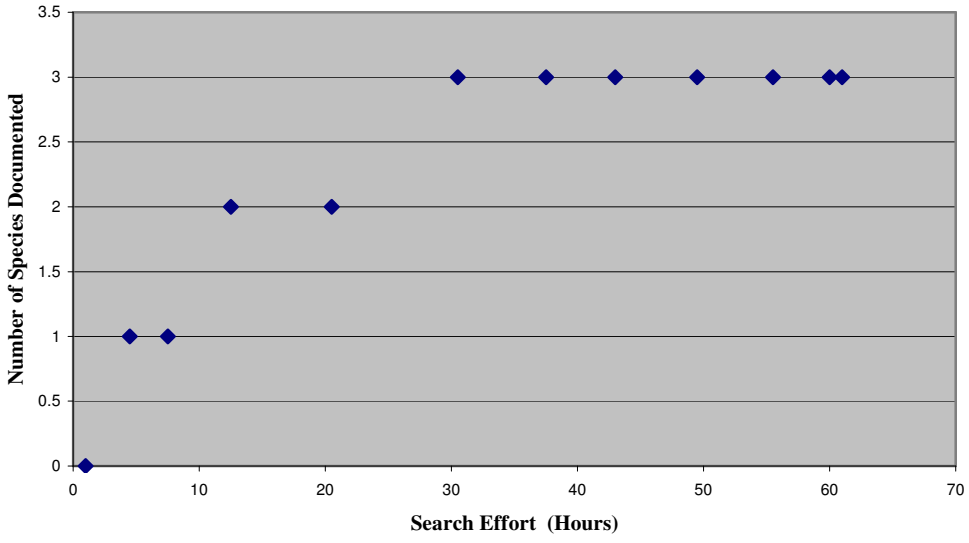

Figure 6. BEOL amphibians: Species accumulation by effort function (visual encounter surveys).

Pitfall traps - The use of pitfall traps, especially in the absence of drift fencing, is an effective but very slow means of capturing amphibians. More than 400 pitfall trap days were needed to capture a single amphibian (a plains leopard frog) (Table XII, Fig. 7). The investment of additional effort in pitfall trapping to capture amphibians would be efficient if it targeted anurans at their breeding sites at the appropriate times.

Table XII. BEOL amphibians: Species accumulation by effort (pitfall trapping).

Search Effort (Pitfall Trap Days)	No. of Species Documented
25	0
65	0
105	0
145	0
185	0
225	0
265	0
305	0
345	0
385	0
425	1

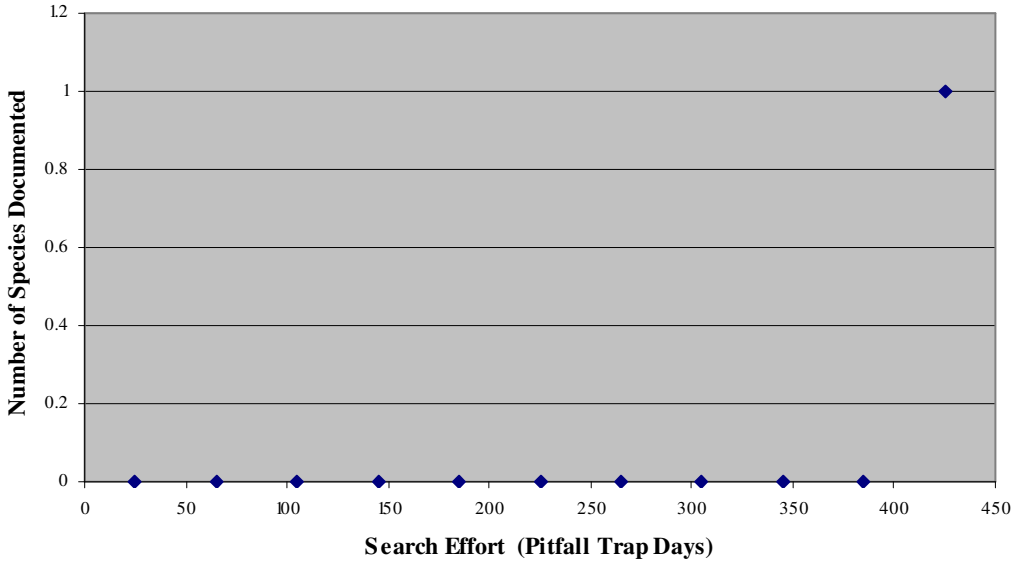

Figure 7. BEOL amphibians: Species accumulation by effort function (pitfall trapping).

Reptiles

Visual encounter surveys - Only seven species of reptiles were documented at BEOL on the basis of more than 60 hours of visual encounter surveys (Table XIII, Fig. 8). Reptiles can be very difficult to detect, however, because they often are cryptically colored and they can be inactive for long periods of time. Many of the species of lizards and snakes that are included on the reptile master species list may be present but undetected at BEOL. The behavior and temporal activity patterns of these animals make them difficult to locate. Additional time spent in VES for reptiles would probably have been successful in documenting the presence of more reptilian species. Movements and other activities of reptiles tend to increase after heavy rainfall (Karns 1986, Hammerson 1999) and so VES for reptiles are most efficient when conducted after warm, heavy rains.

Table XIII. BEOL reptiles: Species accumulation by effort (visual encounter surveys).

Search Effort (Hours)	No. of Species Documented
1	0
4.5	0
7.5	1
12.5	1
20.5	2
30.5	3
37.5	3
43	3
49.5	5
55.5	6
60	7
61	7

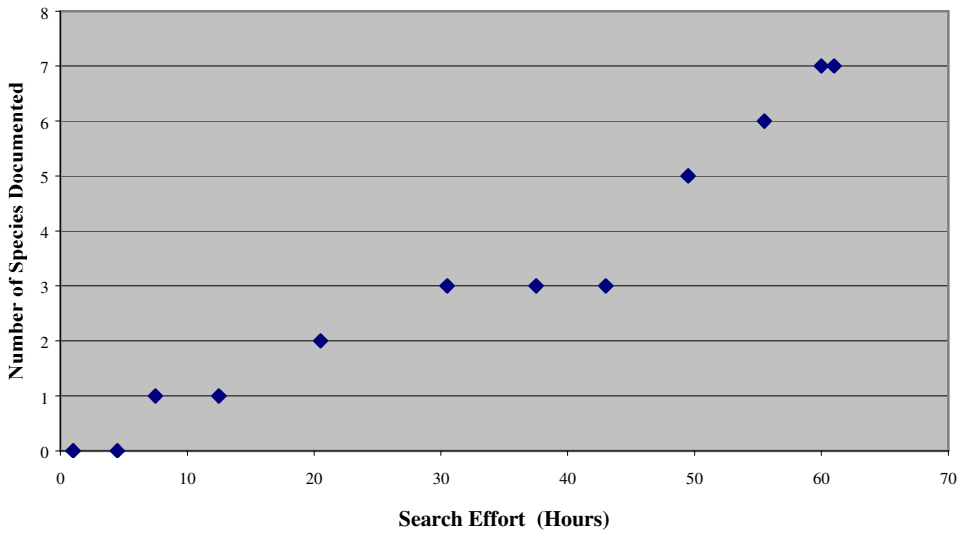

Figure 8. BEOL reptiles: Species accumulation by effort function (visual encounter surveys).

Pitfall traps - Only one reptile (a six-lined racerunner) was captured during more than 400 pitfall trap days (Table XIV, Fig. 9). Additional pitfall trapping probably would have slowly documented the presence of more species as other lizards and snakes gradually found their way into the traps.

Table XIV. BEOL reptiles: Species accumulation by effort (pitfall trapping).

Search Effort (Pitfall Trap Days)	No. of Species Documented
25	0
65	0
105	0
145	0
185	0
225	1
265	1
305	1
345	1
385	1
425	1

A long-term pitfall-trapping program would be needed (in addition to VES, night road surveys, and fixed-point auditory anuran surveys) to provide an accurate assessment of the herpetofauna of BEOL. Arrays of pitfall traps could be established near amphibian breeding sites and in targeted habitat patches for reptiles. The use of drift fencing in combination with pitfall traps would increase the likelihood of capture of several types of amphibians and reptiles (Karns 1986, Corn and Bury 1990). Pitfall traps require frequent checking to prevent the escape or mortality of captured animals, however, and therefore their use can be labor-intensive.

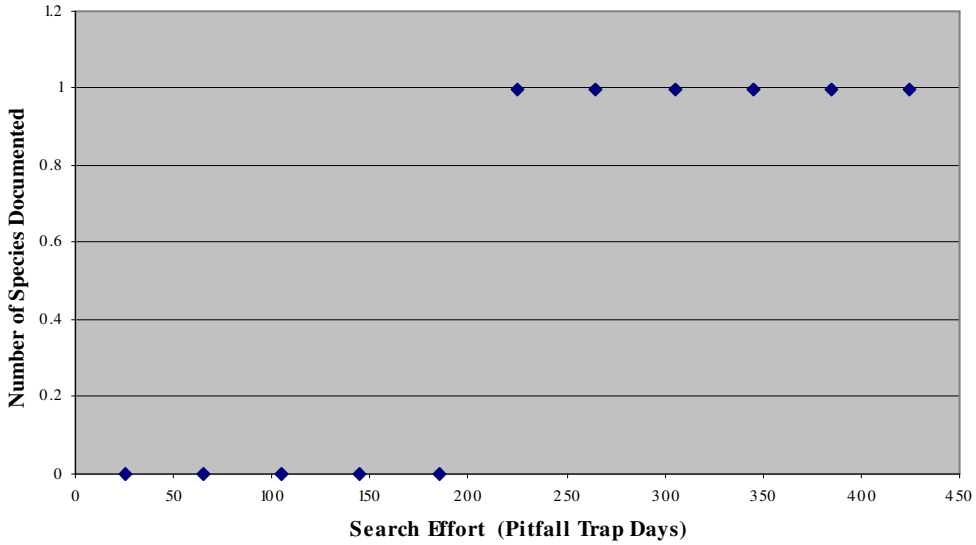

Figure 9. BEOL reptiles: Species accumulation by effort function (pitfall trapping).

Fishes

Dip-netting and seine netting - Eight hours of dip- and seine netting at Day Pond and the Arch Wetland resulted in the capture of fishes of four species (Tables V, XV; Fig. 10). Although additional piscine species may be present in these wetlands, it is unlikely that the use of dip- and seine netting would have succeeded in capturing more species. Water depth and other factors limited the application of these netting techniques to specific locations at these two wetland sites. We probably captured all of the species that could be captured at those locations using dip nets and seine nets.

Table XV. BEOL fishes: Species accumulation by effort (dip- and seine netting).

Search Effort (Hours)	No. of Species Documented
2	1
5.5	4
8.0	4

With a relatively small investment of time and personnel, a survey of the fishes in Day Pond and at the Arch Wetland could be conducted using electro-shocking equipment and a small boat. Such a survey would also detect amphibians.

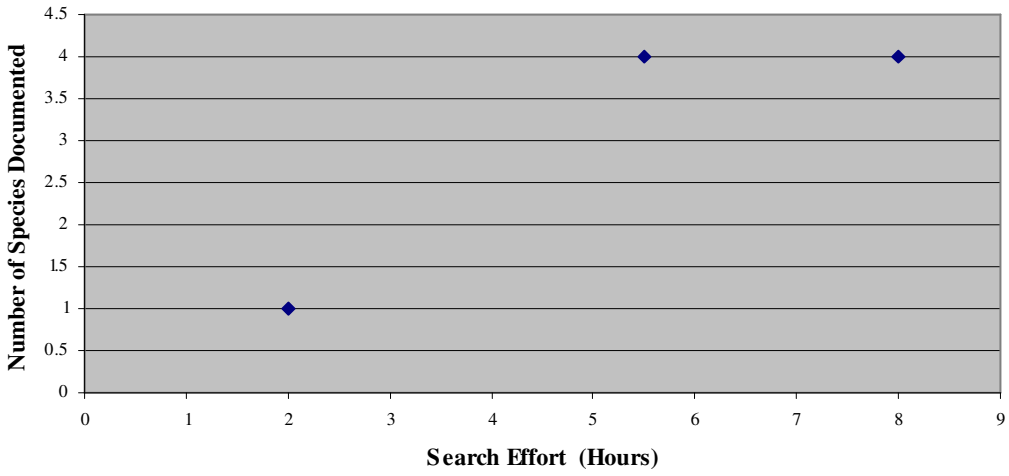

Figure 10. BEOL fishes: Species accumulation by effort function (dip- and seine netting).

SECTION II. WETLAND VASCULAR PLANTS SURVEY

INTRODUCTION

Wetland surveys and assessments were conducted from July 31 through August 2, 2001 at Bents Old Fort National Historical Site (Figure 1). Seven wetland areas were visited, four on the north side of the Arkansas River and three on the south side. For each wetland the precise location was recorded on 1:24,000 scale topographic maps using a Global Positioning System (GPS) unit. Plant collection was limited to voucher specimens of targeted species, and to those species difficult to distinguish in the field. Fifteen voucher specimens with labels were sent to BEOL staff in September 2001 for incorporation into herbarium. Species list were compiled for all seven wetlands, synonymy following *Colorado Flora: Eastern Slope* (Weber and Wittman 2001). The dominant plant communities were derived from the *Comprehensive Statewide Wetland Classification and Characterization* (Carsey et al. 2001).

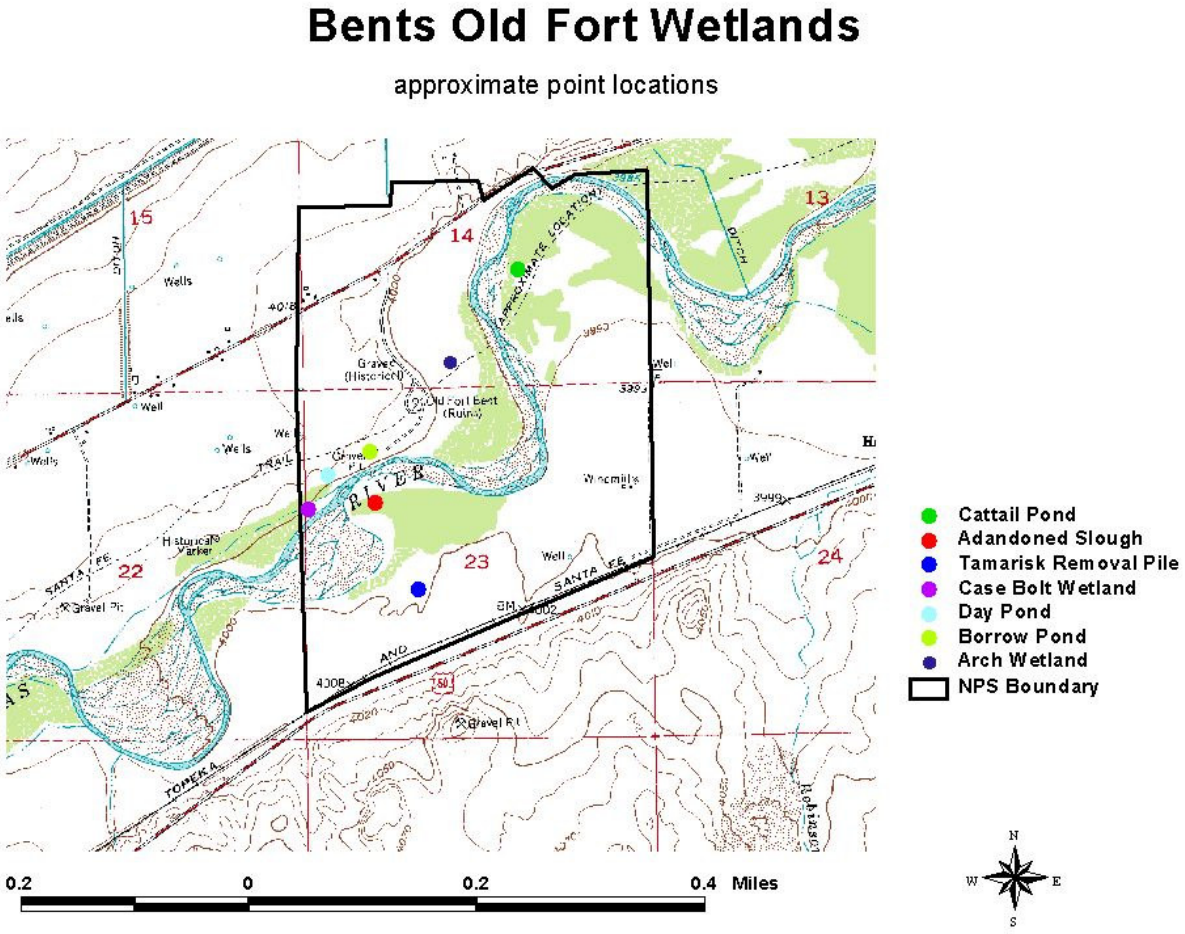

Figure 11. Location of BEOL Wetlands.

METHODS

Wetland surveys at BEOL were conducted using typical natural heritage survey methods. Each wetland visited was surveyed using a combination of ocular estimates and transect line searches. A species list was compiled for all seven wetlands, synonymy following *Colorado Flora: Eastern Slope* (Weber and Wittman 2001). Surveyors visited each wetland area and systematically searched distinct habitats in an attempt to document all species present. Wetland assessments were conducted at each of the wetlands using the hydrogeomorphic approach for conducting wetland functional assessments (Brinson 1993). Two wetland functional assessments were performed on wetlands that were not either dry or manipulated.

The following information was collected for each of the wetlands visited:

General Wetland Information

- plant species list
- proposed HGM Class and Subclass
- Cowardin System and Subsystem
- water source
- hydroperiod
- general soils description (these are based on either a detailed description of a soil profile in the field (i.e., horizons, texture, color, cobble size, percent mottling) or from information from the county soil surveys.

Qualitative Functional Assessment

- hydrological functions (i.e., groundwater recharge/discharge, flood storage, shoreline anchoring)
- biogeochemical functions (i.e., elemental cycling, sediment trapping, and toxicant retention/removal)
- biological functions (i.e., foodchain support, production export, fish and wildlife habitat, habitat diversity)

RESULTS AND DISCUSSION

Seven wetlands were visited, four on the north side of the Arkansas River and three on the south side. Two voucher specimens were collected for species that were not previously documented in BEOL's herbarium. A total of fifteen voucher specimens with labels noting date, location, associated species, and other pertinent information were sent to BEOL staff in September 2001 for incorporation into herbarium.

A comprehensive list of wetland species compiled during the Wetland Survey and Assessment is located in Table 1. The dominant plant communities were determined from the *Comprehensive Statewide Wetland Classification and Characterization* (Carsey et al. 2001).

Table XVI. Wetland Species List for Bents Old Fort National Historic Site.

Common Name	**Scientific Name**	**Status**	**Source**
Snow on the mountain	*Agaloma marginata**	Vouched	BEOL and RM Herbaria
Meadow foxtail	*Alopecurus pratensis*	Vouched	
Ragweed	Ambrosia psilostachya	Vouched	RM Herbarium
Showy milkweed	*Asclepias speciosa*	Vouched	RM Herbarium
Whorled milkweed	*Asclepias subverticillata**	Vouched	BEOL and RM Herbaria
Groundsel tree	*Baccharis salicina*	Vouched	BEOL and RM Herbaria
Kochia	*Bassia sieversiana*	Vouched	BEOL and RM Herbaria
Canada thistle	*Breea arvensis*	Vouched	BEOL and RM Herbaria
Clustered field sedge	*Carex praegracilis**	Vouched	BEOL and RM Herbaria
Lambsquater	*Chenopodium berlandieri**	Vouched	BEOL and RM Herbaria
Teasel	*Dipsacus fullonum*	Vouched	BEOL and RM Herbaria
Saltgrass	*Distichlis spicata**	Vouched	BEOL and RM Herbaria
Barnyard grass	*Echinochloa crus-galli*	Vouched	BEOL and RM Herbaria
Spike rush	*Eleocharis palustris*	Vouched	BEOL and RM Herbaria
Velvet weed	*Gaura parviflora*	Vouched	
Wild licorice	*Glycyrrhiza lepidota*	Vouched	BEOL and RM Herbaria
Common sunflower	*Helianthus annuus*	Vouched	BEOL and RM Herbaria
Duckweed	*Lemna minor***	Vouched	BEOL and RM Herbaria
Alkali muhly	*Muhlenbergia asperifolia*	Vouched	BEOL and RM Herbaria
Vine mesquite	*Panicum obtusum**	Vouched	BEOL and RM Herbaria
Virginia creeper	*Parthenocissus vitacea**	Vouched	BEOL and RM Herbaria
Western wheatgrass	*Pascopyrum smithii*	Vouched	BEOL and RM Herbaria
Common reed	*Phragmites australis**	Vouched	BEOL and RM Herbaria
Knotweed	*Polygonum arenastrum**	Vouched	BEOL and RM Herbaria
Plains cottonwood	*Populus deltoides* ssp. *Monilifera*	Vouched	BEOL and RM Herbaria
Pondweed	*Potamogeton foliosus**	Vouched	BEOL and RM Herbaria
Hawkweed	*Psilochenia runcinata var. runcinata**		
Scurf pea	*Psoralidium tenuiflorum*	Vouched	BEOL and RM Herbaria
Yellow cress	Rorippa sinuata*	Vouched	BEOL and RM Herbaria
Curly dock	Rumex crispus	Vouched	BEOL and RM Herbaria
Arrowhead	*Sagittaria cuneata*	Vouched	BEOL and RM Herbaria
Peach leaved willow	*Salix amygdaloides*		BEOL and RM Herbaria
Sandbar willow	*Salix exigua*	Vouched	BEOL and RM Herbaria
Russian thistle	*Salsola australis*	Vouched	BEOL and RM Herbaria
Hard stem bulrush	Schoenoplectus lacustris *ssp*. Acutus	Vouched	BEOL and RM Herbaria
Common three square	*Schoenoplectus pungens**	Vouched	BEOL and RM Herbaria
Canada goldenrod	Solidago canadensis	Vouched	BEOL and RM Herbaria
Prairie cordgrass	*Spartina pectinata*	Vouched	BEOL and RM Herbaria
Alkali sacaton	*Sporobolus airoides*		BEOL and RM Herbaria
Tamarisk	*Tamarix ramosissima*	Vouched	BEOL and RM Herbaria
Cattail	*Typha latifolia***	Vouched	BEOL and RM Herbaria

* Indicates voucher specimen collected during 2001

** Indicates newly vouched specimen collected during 2001

Wetlands North of Arkansas River

Arch Wetland

Location: T23S R54W Section 23 4 NE
UTMs: 13S 0637902: 4211269
Elevation: 4052 feet

Arch Wetland is located between the Arkansas River and the Old Fort site. It is a 55-acre, semi-permanently flooded wetland with some open water. The hydrology is likely from bank overflow from the Arkansas River and irrigation water leakage from Fort Lyon Canal. The vegetation is dominated by a homogenous stand of cattails (*Typha latifolia*), with some bulrushes (*Schoenoplectus lacustris* ssp. *acutus*, *S. pungens*). The uplands consist of plains cottonwood (*Populus deltoides* ssp. *monilifera*), with Russian olive (*Elaeagnus angustifolia*) and tamarisk (*Tamarix ramosissima*).

Wetland Functional Assessment for the Arch Wetland:
Proposed HGM Class: Depressional Subclass: D2
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Typha angustifolia – Typha latifolia* plant association
Soils: Silty clay, fine texture, gleyed color, 5/10G. 5-10% mottling.

Function	Rating	Comments
Overall Functional Integrity	At potential	
Hydrological Functions		
Flood Attenuation and Storage	High	The wetland occurs within the floodplain of the Arkansas River. The dense vegetative cover and restricted outlet provide a high potential for flood storage and attenuation. The wetland is likely inundated during high flow events on the Arkansas River. It should be noted that upstream alterations in hydrology (e.g., dams, channelization) have drastically affected the flooding cycle of the Arkansas River.
Sediment/Shoreline Stabilization	N/A	Does not occur on a channel.
Groundwater Discharge/ Recharge	Yes	Wetland is part of the Arkansas River floodplain and hydrologic system. Wetland likely intercepts groundwater discharge headed toward the Arkansas Rive, especially from the Fort Lyon Canal.
Dynamic Surface Water Storage	High	Can receive runoff from surrounding uplands. Good potential for surface water storage. Permanent inundation of a small area
Biogeochemical Functions		
Elemental Cycling	Moderate	High aboveground primary productivity and detritus and organic soil horizon indicate that nutrient cycles are intact.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	High capacity to trap sediments during high flow events on the Arkansas River. Fine-grained sediments and decomposing organic matter indicate nutrient removal potential.

Biological Functions		
Habitat Diversity	Moderate	Habitat types include emergent wetlands (extensive area) and open water. (small area). The wetland is adjacent to the Arkansas River riparian corridor with cottonwood, Russian olive, and tamarisk.
General Wildlife Habitat	Moderate	Large size provides good bird nesting habitat. Due to seasonal wetness, good for predators (e.g., coyote, raccoon) to access. Observed soft shelled turtle in pond area.
General Fish/Aquatic Habitat	Low	Likely minnows, but none observed.
Production Export/Food Chain Support	Moderate	High vegetative cover, moderate habitat diversity, and perennial surface water contribute to a diverse array of organic substances and nutrients that potentially transport downstream during high flood events on the Arkansas River or via groundwater flow.
Uniqueness	Low	Though this cattail stand is one of the largest noted on the Arkansas River in Otero County, this community type is very common and larger, better quality stands probably exist elsewhere. These occurrences are locally significant. Large-scale, hydrologically unaltered (other than changes to flood regime on Arkansas River), native vegetation wetlands are not common on the plains.

Species List for Arch Wetland

Agaloma marginata
Asclepias speciosa
Asclepias verticillata
Breea arvensis
Cardaria sp.
Carex praegracilis
Chenopodium berlandieri
Distichlis spicata
Eleocharis palustris
Helianthus annuus
Lemna minor
Muhlenbergia asperifolia
Panicum obtusum
Populus deltoides ssp. *monilifera*
Rorippa sinuata
Rumex crispus
Schoenoplectus lacustris ssp. *acutus*
Spartina pectinata
Typha latifolia

Borrow Pond

Location: T23S R54W Section 23 4 NE
UTM Coordinates: 13S 0637640: 4211052
Elevation 4006 feet

Borrow Pond is an excavated wetland south of the reconstructed fort. It is located north of the Arkansas River, but there is no hydrological connection to the Arkansas River. It is a depression with moderately steep sides. There was no water observed within the wetland, however the soils did show inundation likely during summer thunderstorms. The vegetation along the banks is dominated by cattails (*Typha latifolia*) and bulrushes (*Schoenoplectus lacustris* ssp. *acutus*). The uplands consist of shortgrass prairie and hay meadows.

No functional assessment was performed on the Borrow Pond due to its anthropogenic origin.

Species List

Bassia sieversiana
Dipsacus fullonum
Distichlis spicata
Eleocharis palustris
Glycyrrhiza lepidota
Muhlenbergia asperifolia
Psoralidium tenuiflorum
Salsola australis
Schoenoplectus lacustris ssp. acutus
Schoenoplectus pungens
Solidago canadensis
Tamarix ramosissima
Typha latifolia

Day Pond

Location: T23S R54W Section 23 4 NE
UTM Coordinates: 13S 0637457: 4210922
Elevation: 3992 feet

Day Pond is open water wetland located just south of the reconstructed fort and north of the Arkansas River. It was likely an excavated gravel pit for it is deep with steep sides. The sparse wetland vegetation along the sides of the pond is dominated by bulrushes (*Schoenoplectus lacustris* ssp. *acutus*) and cattails (*Typha latifolia*).

No functional assessment was performed for this wetland due to its anthropogenic origins.

Species List

Agaloma marginata
Alopecurus pratensis
Ambrosia psilostachya
Bassia sieversiana
Carex praegracilis
Chenopodium sp.
Distichlis spicata
Helianthus annuu
Muhlenbergia asperifolia
Polygonum arenastrum
Populus deltoides ssp. monilifera
Salix exigua
Schoenoplectus lacustris ssp. *acutus*
Schoenoplectus pungens
Typha latifolia

Case Bolt Wetland

Location: T23S R54W Section 23
UTM Coordinates: 13S 0637349: 4210737
Elevation: 4025 feet

Case Bolt wetland is a small, open water wetland located 100 feet south of the Day Pond. It is very small, > 0.5 acres, wetland. During the survey open water was observed but very shallow. The soils indicate that this wetland is permanently inundated. The source of water is likely from irrigation water overflow from adjacent culvert or from seepage from the Day Pond. The surrounding uplands are in the Arkansas River floodplain, dominated by plains cottonwood (*Populus deltoides* ssp. *monilifera*).

Wetland Functional Assessment for the Case Bolt Wetland:
Proposed HGM Class: Depressional Subclass: D2
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Potamogeton foliosus*
Soils: Silty clay loam, gleyed 6/N, 5% mottles

Function	Rating	Comments
Overall Functional Integrity	At potential	
Hydrological Functions		
Flood Attenuation and Storage	Low	This wetland occurs within the floodplain of the Arkansas River. This wetland is likely inundated during high flow events on the Arkansas River.
Sediment/Shoreline Stabilization	N/A	Does not occur on a channel.
Groundwater Discharge/ Recharge	Yes	Wetland is part of the Arkansas River floodplain and hydrologic system. Wetland likely intercepts seepage from adjacent irrigation and Day Pond.
Dynamic Surface Water Storage	High	Can receive runoff from surrounding uplands. Good potential for surface water storage. Permanent inundation of a small area
Biogeochemical Functions		
Elemental Cycling	Moderate	High aboveground primary productivity and detritus and organic soil horizon indicate that nutrient cycles are intact.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	High capacity to trap sediments during high flow events on the Arkansas River. Fine-grained sediments and decomposing organic matter indicate nutrient removal potential.
Biological Functions		
Habitat Diversity	Moderate	Habitat types include emergent wetlands (small area) and open water. (small area). The wetland is adjacent to the Arkansas River riparian corridor with cottonwood, Russian olive, and tamarisk.
General Wildlife Habitat	Moderate	Even though wetland is small is does provide good bird nesting habitat. Due to seasonal wetness, good for predators (e.g., coyote, raccoon) to access. Observed several dragonflies around pond.
General Fish/Aquatic Habitat	Low	None observed.

Biological Functions		
Production Export/Food Chain Support	Moderate	High vegetative cover, moderate habitat diversity, and perennial surface water contribute to a diverse array of organic substances and nutrients that potentially transport downstream during high flood events on the Arkansas River or via groundwater flow.
Uniqueness	Low	This community type is very common in the Arkansas River watershed.

Species List

Ambrosia psilostachya
Asclepias speciosus
Distichlis spicata
Echinochloa crus-galli
Glycyrrhiza lepidota
Panicum obtusum
Populus deltoides ssp. monilifera
Potamogeton foliosus
Sagittaria cuneata
Salix exigua
Typha latifolia

Wetlands South of Arkansas River and BEOL

Tamarisk pile near 2-track road

Location: T23S R54W Section 23
UTM Coordinates: 13S 0637680: 4210791
Elevation: 4010 feet

BEOL resource managers wanted a species list from this area. It is a depression that has been used as a staging area for tamarisk removal.

No functional assessment was performed on this site.

Species List

Asclepias speciosus
Bassia sieversiana
Distichlis spicata
Gaura parviflora
Helianthus annuus
Pascopyrum smithii
Populus deltoides ssp. monilifera
Spartina pectinata
Sporobolus airoides
Tamarix ramosissima

Abandoned Slough

Location: T23S R54W Section 23
UTM Coordinates: 13S 0637680: 4210791
Elevation 4000 feet

This area is an abandoned slough from the Arkansas River. It is depression that likely receives overflow from the Arkansas River during very large flooding events. It is dominated by plains cottonwood (*Populus deltoides* ssp. *monilifera*) with peach leaf willow (*Salix amygdaloides*) and coyote willow (*Salix exigua*). Soils were sandy loam (10YR 2/1) with no evidence of prolonged inundation. However, soils were moist indicating that the groundwater level was near the surface.

No functional assessment was performed on this site.

Species List

Breea arvensis
Glycyrrhiza lepidota
Parthenocissus vitacea
Phragmites australis
Populus deltoides ssp. Monilifera
Psilochenia runcinata var. *runcinata*
Rumex crispus
Salix amygdaloides
Salix exigua
Tamarix ramosissima

Cattail Pond

Location: T23S R54W Section 23
UTM Coordinates: 13S 0638368: 4211884
Elevation 4017 feet

This area is a depression that supports a small occurrence of cattails (*Typha latifolia*). However, there was no open water observed at the time of the survey. This area likely receives water from bank overflow during large flooding events or surface water from summer thunderstorms. Soils did indicate periods of prolonged indication by being gleyed (6/N). However, at the time of the survey no open water was observed.

No functional assessment was performed on this site.

Species List

Baccharis salicina
Breea arvensis
Eleocharis palustris
Helianthus annuus
Populus deltoides ssp. monilifera
Tamarix ramosissima
Typha latifolia

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Appendix I. Bent's Old Fort National Historic Site Documented Breeding Bird Species List.

Common Name	Scientific Name	Date Documented	UTM (easting)	UTM (northing)
Great Blue Heron	*Ardea herodias*	14 Aug 2001	0638103	4211709
Green Heron	*Butorides virescens*	11 Aug 2001	0638073	4211731
Turkey Vulture	*Cathartes aura*	9 Aug 2001	0638423	4210429
Mallard	*Anas platyrhynchos*	6 Aug 2001	0637346	4210837
Northern Harrier	*Circus cyaneus*	9 Aug 2001	0638169	4210870
Swainson's Hawk	*Buteo swainsoni*	11 Aug 2001	0638900	4210809
Red-tailed Hawk	*Buteo jamaicensis*	9 Aug 2001	0638450	4210476
Ferruginous Hawk	*Buteo regalis*	17 Aug 2001	0638541	4210386
American Kestrel	*Falco sparverius*	7 Aug 2001	0637978	4210616
Ring-necked Pheasant	*Phasianus colchicus*	18 Aug 2001	0637351	4211026
Wild Turkey	*Meleagris gallopavo*	8 Aug 2001	0638351	4211173
Northern Bobwhite	*Colinus virginianus*	7 Aug 2001	0637628	4210327
Killdeer	*Charadrius vociferus*	7 Aug 2001	0638108	4211705
Spotted Sandpiper	*Actitis macularia*	13 Aug 2001	0638602	4211135
Rock Dove	*Columba livia*	11 Aug 2001	0637471	4210785
Mourning Dove	*Zenaida macroura*	8 Aug 2001	0638456	4211703
Yellow-billed Cuckoo	*Coccyzus americanus*	8 Aug 2001	0638386	4211225
Great Horned Owl	*Bubo virginianus*	7 Aug 2001	0637982	4210664
Common Nighthawk	*Chordeiles minor*	10 Aug 2001	0638281	4211080
Red-headed Woodpecker	*Melanerpes erythrocephalus*	7 Aug 2001	0638098	4210864
Downy Woodpecker	*Picoides pubescens*	8 Aug 2001	0638515	4211528
Red-shafted (Northern) Flicker	*Colaptes auratus*	11 Aug 2001	0638262	4211197
Western Wood-Pewee	*Contopus sordidulus*	9 Aug 2001	0637961	4210866
Ash-throated Flycatcher	*Myiarchus cinerascens*	17 Aug 2001	0638390	4212050
Cassin's Kingbird	*Tyrannus vociferans*	9 Aug 2001	0637659	4210278

Common Name	Scientific Name	Date Documented	UTM (easting)	UTM (northing)
Western Kingbird	*Tyrannus verticalis*	7 Aug 2001	0638864	4210520
Eastern Kingbird	*Tyrannus tyrannus*	7 Aug 2001	0637407	4210260
Loggerhead Shrike	*Lanius ludovicianus*	12 Aug 2001	0637658	4210274
Blue Jay	*Cyanocitta cristata*	9 Aug 2001	0637956	4210772
Black-billed Magpie	*Pica pica*	9 Aug 2001	0637792	4210338
American Crow	*Corvus brachyrhynchos*	17 Aug 2001	0637803	4210716
Barn Swallow	*Hirundo rustica*	10 Aug 2001	0638470	4210806
House Wren	*Troglodytes aedon*	8 Aug 2001	0638602	4211572
Eastern Bluebird	*Sialia sialis*	from Nancy Keohane	from Nancy Keohane	from Nancy Keohane
American Robin	*Turdus migratorius*	14 Aug 2001	0638897	4210866
Brown Thrasher	*Toxostoma rufum*	9 Aug 2001	0637659	4210278
European Starling	*Sturnus vulgaris*	11 Aug 2001	0638902	4210865
Cassin's Sparrow	*Aimophila cassinii*	13 Aug 2001	0638948	4211061
Chipping Sparrow	*Spizella passerina*	15 Aug 2001	0637339	4211344
Lark Sparrow	*Chondestes grammacus*	9 Aug 2001	0637340	4211197
Lark Bunting	*Calamospiza melanocorys*	10 Aug 2001	0637340	4211372
Grasshopper Sparrow	*Ammodramus savannarum*	12 Aug 2001	0637339	4211327
Blue Grosbeak	*Guiraca caerulea*	7 Aug 2001	0637898	4210459
Dickcissel	*Spiza americana*	10 Aug 2001	0637339	4211399
Red-winged Blackbird	*Agelaius phoeniceus*	9 Aug 2001	0637340	4211197
Western Meadowlark	*Sturnella neglecta*	8 Aug 2001	0637787	4211066
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	9 Aug 2001	0637340	4211197
Common Grackle	*Quiscalus quiscula*	8 Aug 2001	0638233	4211071
Brown-headed Cowbird	*Molothrus ater*	16 Aug 2001	0637301	4211685
Bullock's Oriole	*Icterus bullockii*	10 Aug 2001	0638302	4211651
American Goldfinch	*Carduelis tristis*	8 Aug 2001	0638423	4210859
House Sparrow	*Passer domesticus*	12 Aug 2001	0637840	4211232

Appendix II. Bent's Old Fort National Historic Site Documented Mammal Species List.

Common Name	Scientific Name	Date Documented	UTM (easting)	UTM (northing)
Desert Shrew	*Notiosorex crawfordi*	from Nancy Keohane	from Nancy Keohane	from Nancy Keohane
Desert Cottontail	*Sylvilagus audubonii*	7 Aug 2001	0637797	4210567
Black-tailed Jackrabbit	*Lepus californicus*	10 Aug 2001	0638867	4210594
Spotted Ground Squirrel	*Spermophilus spilosoma*	17 Aug 2001	0638450	4210695
Black-tailed Prairie Dog	*Cynomys ludovicianus*	7 Aug 2001	0638867	4210594
Fox Squirrel	*Sciurus niger*	11 Aug 2001	0638220	4211176
Hispid Pocket Mouse	*Chaetodipus hispidus*	10 Aug 2001	0637477	4211037
Ord's Kangaroo Rat	*Dipodomys ordii*	16 Aug 2001	0637375	4210464
American Beaver	*Castor canadensis*	17 Aug 2001	0637569	4210876
Western Harvest Mouse	*Reithrodontomys megalotis*	8 Aug 2001	0637816	4210563
Deer Mouse	*Peromyscus maniculatus*	7 Aug 2001	0637376	4210738
White-footed Mouse	*Peromyscus leucopus*	12 Aug 2001	0638199	4210855
Northern Grasshopper Mouse	*Onychomys leucogaster*	16 Aug 2001	0638468	4210709
Hispid Cotton Rat	*Sigmodon hispidus*	7 Aug 2001	0638076	4211708
White-throated Woodrat	*Neotoma albigula*	8 Aug 2001	0638199	4210855
Common Muskrat	*Ondatra zibethicus*	6 Aug 2001	0637798	4211790
Coyote	*Canis latrans*	16 Aug 2001	0638637	4211536
Raccoon	*Procyon lotor*	9 Aug 2001	0638308	4211943
Mule Deer	*Odocoileus hemionus*	12 Aug 2001	0638361	4211013
White-tailed Deer	*Odocoileus virginianus*	8 Aug 2001	0637345	4210933

Appendix III. Bent's Old Fort National Historic Site Documented Amphibian and Reptile Species List.

Common Name	Scientific Name	Date Documented	UTM (easting)	UTM (northing)
Woodhouse's Toad	*Bufo woodhousii*	15 Aug 2001	0637428	4211700
Plains Leopard Frog	*Rana blairi*	10 Aug 2001	0638073	4211731
Bullfrog	*Rana catesbeiana*	15 Aug 2001	0637771	4211789
Spiny Softshell Turtle	*Apalone spinifera*	11 Aug 2001	0637424	4210850
Texas Horned Lizard	*Phrynosoma cornutum*	17 Aug 2001	0638731	4210936
Six-Lined Racerunner	*Cnemidophorus sexlineatus*	9 Aug 2001	0638697	4211486
Great Plains Skink	*Eumeces obsoletus*	15 Aug 2001	0637433	4211683
Bullsnake	*Pituophis catenifer*	15 Aug 2001	0637643	4209935
Plains Garter Snake	*Thamnophis radix*	12 Aug 2001	0638073	4211731
Western Rattlesnake	*Crotalus viridis*	15 Aug 2001	0638760	4210865

Appendix IV. Bent's Old Fort National Historic Site Documented Fish Species List.

Common Name	Scientific Name	Date Documented	UTM (easting)	UTM (northing)
Common Carp	*Cyprinus carpio*	12 Aug 2001	0637441	4210885
Plains Killifish	*Fundulus zebrinus*	12 Aug 2001	0637771	4211789
Mosquitofish	*Gambusia affinis*	8 Aug 2001	0637424	4210850
Green Sunfish	*Lepomis cyanellus*	12 Aug 2001	0637441	4210885

Appendix V. Bent's Old Fort National Historic Site Annotated Breeding Bird Species List.

Common Name	Scientific Name	Date Documented	Comments
Great Blue Heron	*Ardea herodias*	14 Aug 2001	1 observation of 1 bird along Arkansas River
Green Heron	*Butorides virescens*	11 Aug 2001	3 observations of lone bird or a pair of birds, always along Arkansas River
Turkey Vulture	*Cathartes aura*	9 Aug 2001	2 observations of lone bird soaring over grassland at south end of BEOL property
Mallard	*Anas platyrhynchos*	6 Aug 2001	1 observation of lone female at Arch Wetland
Northern Harrier	*Circus cyaneus*	9 Aug 2001	about 4-5 observations of lone bird hunting over open grassland; both sides of river
Swainson's Hawk	*Buteo swainsoni*	11 Aug 2001	1 observation of lone bird
Red-tailed Hawk	*Buteo jamaicensis*	9 Aug 2001	numerous observations; always 1 bird seen
Ferruginous Hawk	*Buteo regalis*	17 Aug 2001	1 observation of lone bird soaring over grassland to south of Arkansas River
American Kestrel	*Falco sparverius*	7 Aug 2001	often observed on both sides of Arkansas River
Ring-necked Pheasant	*Phasianus colchicus*	18 Aug 2001	1 observation of a male to north of river; 1 unconfirmed observation of a female to south of river
Wild Turkey	*Meleagris gallopavo*	8 Aug 2001	adults and young were often observed together under cottonwood trees on both sides of river
Northern Bobwhite	*Colinus virginianus*	7 Aug 2001	often heard and seen on both sides of river; sometimes seen in pairs
Killdeer	*Charadrius vociferus*	7 Aug 2001	often seen along river and in open grassland areas
Spotted Sandpiper	*Actitis macularia*	13 Aug 2001	1 observation of lone bird along Arkansas River
Rock Dove	*Columba livia*	11 Aug 2001	1 observation of 2 birds drinking along shore of Arkansas River
Mourning Dove	*Zenaida macroura*	8 Aug 2001	very often seen and heard on both sides of Arkansas River
Yellow-billed Cuckoo	*Coccyzus americanus*	8 Aug 2001	often observed on both sides of Arkansas River
Great Horned Owl	*Bubo virginianus*	7 Aug 2001	often seen and heard on both sides of Arkansas River
Common Nighthawk	*Chordeiles minor*	10 Aug 2001	often seen roosting in dead trees (days) and foraging overhead (evenings)
Red-headed Woodpecker	*Melanerpes erythrocephalus*	7 Aug 2001	often seen and heard on both sides of Arkansas River
Downy Woodpecker	*Picoides pubescens*	8 Aug 2001	several observations on both sides of Arkansas River
Red-shafted (Northern) Flicker	*Colaptes auratus*	11 Aug 2001	often seen and heard on both sides of Arkansas River
Western Wood-Pewee	*Contopus sordidulus*	9 Aug 2001	often seen on both sides of Arkansas River

Common Name	Scientific Name	Date Documented	Comments
Ash-throated Flycatcher	*Myiarchus cinerascens*	17 Aug 2001	1 observation of lone bird to south of river
Cassin's Kingbird	*Tyrannus vociferans*	9 Aug 2001	often seen on both sides of Arkansas River
Western Kingbird	*Tyrannus verticalis*	7 Aug 2001	often seen on both sides of Arkansas River
Eastern Kingbird	*Tyrannus tyrannus*	7 Aug 2001	often seen on both sides of Arkansas River
Loggerhead Shrike	*Lanius ludovicianus*	12 Aug 2001	often seen on both sides of Arkansas River
Blue Jay	*Cyanocitta cristata*	9 Aug 2001	often seen on both sides of Arkansas River
Black-billed Magpie	*Pica pica*	9 Aug 2001	often seen on both sides of Arkansas River
American Crow	*Corvus brachyrhynchos*	17 Aug 2001	1 bird heard once on north side of Arkansas River
Barn Swallow	*Hirundo rustica*	10 Aug 2001	often seen on both sides of Arkansas River; nesting inside the fort; seen foraging over open grassland areas
House Wren	*Troglodytes aedon*	8 Aug 2001	often seen on both sides of Arkansas River; sometimes seen in pairs
Eastern Bluebird	*Sialia sialis*	unknown	carcass provided by Nancy Keohane
American Robin	*Turdus migratorius*	14 Aug 2001	often seen on south side of Arkansas River
Brown Thrasher	*Toxostoma rufum*	9 Aug 2001	often seen on both sides of Arkansas River
European Starling	*Sturnus vulgaris*	11 Aug 2001	several observations of flocks of starlings or flocks of mixed blackbirds that include starlings; both sides of Arkansas River
Cassin's Sparrow	*Aimophila cassinii*	13 Aug 2001	on several occasions, a small flock was seen foraging along gravel road at west edge of BEOL property, to north of Arkansas River
Chipping Sparrow	*Spizella passerina*	15 Aug 2001	on several occasions, a small flock was seen foraging along gravel road at west edge of BEOL property, to north of Arkansas River
Lark Sparrow	*Chondestes grammacus*	9 Aug 2001	on several occasions, a small flock was seen foraging along gravel road at west edge of BEOL property, to north of Arkansas River
Lark Bunting	*Calamospiza melanocorys*	10 Aug 2001	on several occasions, a small flock was seen foraging along gravel road at west edge of BEOL property, to north of Arkansas River
Grasshopper Sparrow	*Ammodramus savannarum*	12 Aug 2001	on several occasions, a small flock was seen foraging along gravel road at west edge of BEOL property, to north of Arkansas River
Blue Grosbeak	*Guiraca caerulea*	7 Aug 2001	often seen on both sides of river; seen singly and in small flocks

Common Name	Scientific Name	Date Documented	Comments
Dickcissel	*Spiza americana*	10 Aug 2001	1 male was seen and heard (once) singing along gravel road at west edge of BEOL property, to north of Arkansas River
Red-winged Blackbird	*Agelaius phoeniceus*	9 Aug 2001	often seen on south side of Arkansas River; also, several observations of many Red-winged Blackbirds in large, mixed-blackbird flocks at Arch Wetland and around agricultural fields
Western Meadowlark	*Sturnella neglecta*	8 Aug 2001	often seen on both sides of Arkansas River
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	9 Aug 2001	several observations of many Yellow-headed Blackbirds in large, mixed-blackbird flocks at Arch Wetland and around agricultural fields
Common Grackle	*Quiscalus quiscula*	8 Aug 2001	often seen on south side of Arkansas River; also, several observations of many Red-winged Blackbirds in large, mixed-blackbird flocks at Arch Wetland and around agricultural fields
Brown-headed Cowbird	*Molothrus ater*	16 Aug 2001	many cowbirds observed once in a large mixed-blackbird flock in agricultural field at north end of BEOL property
Bullock's Oriole	*Icterus bullockii*	10 Aug 2001	often seen in woodland on south side of Arkansas River
American Goldfinch	*Carduelis tristis*	8 Aug 2001	several observations of small flocks on both sides of Arkansas River
House Sparrow	*Passer domesticus*	12 Aug 2001	small flock observed repeatedly at fort, in and around livestock areas

Appendix VI. Bent's Old Fort National Historic Site Annotated Mammal Species List.

Common Name	Scientific Name	Date Documented	Comments [1]
Desert Shrew	*Notiosorex crawfordi*	unknown	carcass provided by Nancy Keohane on 8-18-2001
Desert Cottontail	*Sylvilagus audubonii*	7 Aug 2001	often observed on both sides of Arkansas River
Black-tailed Jackrabbit	*Lepus californicus*	10 Aug 2001	1 observation of lone jackrabbit at the black-tailed prairie dog town
Spotted Ground Squirrel	*Spermophilus spilosoma*	17 Aug 2001	1 subadult captured; no other observations
Black-tailed Prairie Dog	*Cynomys ludovicianus*	7 Aug 2001	observed daily at prairie dog town
Fox Squirrel	*Sciurus niger*	11 Aug 2001	1 confirmed observation of 2 squirrels together in tree; 2 other unconfirmed observations of lone animals on ground
Hispid Pocket Mouse	*Chaetodipus hispidus*	10 Aug 2001	7 adults and 10 subadults captured in live traps
Ord's Kangaroo Rat	*Dipodomys ordii*	16 Aug 2001	3 adults captured in live traps
American Beaver	*Castor canadensis*	17 Aug 2001	observed sign (tracks, damage to cottonwood trees) at 1 location along south shore of Arkansas River
Western Harvest Mouse	*Reithrodontomys megalotis*	8 Aug 2001	11 adults captured in live traps
Deer Mouse	*Peromyscus maniculatus*	7 Aug 2001	134 adults and 13 subadults captured in live traps
White-footed Mouse	*Peromyscus leucopus*	12 Aug 2001	1 adult captured in a live trap
Northern Grasshopper Mouse	*Onychomys leucogaster*	16 Aug 2001	2 adults captured in live traps
Hispid Cotton Rat	*Sigmodon hispidus*	7 Aug 2001	52 adults and 17 subadults captured in live traps
White-throated Woodrat	*Neotoma albigula*	8 Aug 2001	17 adults and 3 subadults captured in live traps
Common Muskrat	*Ondatra zibethicus*	6 Aug 2001	2 observations of lone animal swimming at Arch Wetland
Coyote	*Canis latrans*	16 Aug 2001	1 observation of lone animal; vocalizations were often heard, and coyote scat was often observed along roads and in field
Raccoon	*Procyon lotor*	9 Aug 2001	3 adults captured in live traps; also, 1 observation of 2 animals, and numerous observations of tracks
Mule Deer	*Odocoileus hemionus*	12 Aug 2001	2 observations: lone doe to north of river; 4 bucks to south of river
White-tailed Deer	*Odocoileus virginianus*	8 Aug 2001	2 does, each with 2 fawns, were seen daily near Day Pond; other observations on both sides of Arkansas River

[1] capture totals include recaptures

Appendix VII. Bent's Old Fort National Historic Site Annotated Amphibian and Reptile Species List.

Common Name	Scientific Name	Date Documented	Comments
Woodhouse's Toad	*Bufo woodhousii*	15 Aug 2001	numerous observations around fort and around maintenance buildings
Plains Leopard Frog	*Rana blairi*	10 Aug 2001	numerous observations around Arch Wetland and in road puddles near river
Bullfrog	*Rana catesbeiana*	15 Aug 2001	vocalizations often heard at Day Pond and at Arch Wetland
Spiny Softshell Turtle	*Apalone spinifera*	11 Aug 2001	numerous observations of 1 large individual swimming in Day Pond
Texas Horned Lizard	*Phrynosoma cornutum*	17 Aug 2001	1 observation of 1 juvenile
Six-Lined Racerunner	*Cnemidophorus sexlineatus*	9 Aug 2001	2 observations of lone animals
Great Plains Skink	*Eumeces obsoletus*	15 Aug 2001	1 observation of 1 hatchling; 1 subadult caught on sticky trap (from Nancy Keohane)
Bullsnake	*Pituophis catenifer*	15 Aug 2001	1 observation of a roadkilled snake along southern boundary of BEOL property
Plains Garter Snake	*Thamnophis radix*	12 Aug 2001	2 observations of lone animals: at Arch Wetland and in puddle along dirt road to south of Arkansas River
Western Rattlesnake	*Crotalus viridis*	15 Aug 2001	2 observations of lone animals: 1 on each side of Arkansas River

Appendix VIII. Bent's Old Fort National Historic Site Annotated Fish Species List.

Common Name	Scientific Name	Date Documented	Comments
Common Carp	*Cyprinus carpio*	12 Aug 2001	at least 2 large individuals were observed in Day Pond
Plains Killifish	*Fundulus zebrinus*	12 Aug 2001	numerous individuals caught at Day Pond and at Arch Wetland
Mosquitofish	*Gambusia affinis*	8 Aug 2001	numerous individuals caught at Day Pond and at Arch Wetland
Green Sunfish	*Lepomis cyanellus*	12 Aug 2001	numerous individuals caught at Day Pond and at Arch Wetland

Appendix IX. Vertebrate Photographic Log (35-mm), BEOL, August 2001

Appendix X. Vertebrate Photographic Log (digital), BEOL, August 2001

Appendix XI. Wetland Information.

Wetland Definitions

The federal regulatory definition of a jurisdictional wetland is found in the regulations used by the U.S. Army Corps of Engineers (Corps) for the implementation of a dredge and fill permit system required by Section 404 of the Clean Water Act Amendments (Mitsch and Gosselink 1993). According to the Corps, wetlands are "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." For Corps programs, a wetland boundary must be determined according to the mandatory technical criteria described in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987). In order for an area to be classified as a jurisdictional wetland (i.e., a wetland subject to federal regulations), it must have **all** three of the following criteria: (1) wetland plants; (2) wetland hydrology; and (3) hydric soils.

The U.S. Fish and Wildlife Service defines wetlands from an ecological point of view. In *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979) the definition states that "wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water." Wetlands must have *one or more* of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes (wetland plants); (2) the substrate is predominantly undrained hydric soil; and/or (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. This definition only requires that an area meet one of the three criteria (vegetation, soils, and hydrology) in order to be classified as a wetland.

CNHP prefers the wetland definition used by the U.S. Fish and Wildlife Service, because it recognizes that some areas display many of the attributes of wetlands without exhibiting all three characteristics required to fulfill the Corps' criteria. Additionally, riparian areas (riverine corridors), which often do not meet all three of the Corps criteria, should be included in a wetland conservation program. Riparian areas perform many of the same functions as do wetlands, including maintenance of water quality, storage of floodwaters, and enhancement of biodiversity, especially in the western United States (National Research Council 1995).

Wetland Functions and Values

Wetlands perform many functions beyond simply providing habitat for plants and animals. It is commonly known that wetlands act as natural filters, helping to protect water quality, but it is less well known that wetlands perform other important functions. Adamus et al. (1991) list the following functions performed by wetlands:

- Groundwater recharge--the replenishing of below ground aquifers.
- Groundwater discharge--the movement of groundwater to the surface (e.g., springs).
- Flood flow alteration--the temporary storage of potential floodwaters.
- Sediment stabilization--the protection of stream banks and lake shores from erosion.
- Sediment/toxicant retention--the removal of suspended soil particles from the water, along with toxic substances that may be adsorbed to these particles.
- Nutrient removal/transformation--the removal of excess nutrients from the water, in particular nitrogen and phosphorous. Phosphorous is often removed via sedimentation; transformation includes converting inorganic forms of nutrients to organic forms and/or the conversion of one inorganic form to another inorganic form (e.g., NO_3^- converted to N_2O or N_2 via denitrification).

- Production export--supply organic material (dead leaves, soluble organic carbon, etc.) to the base of the food chain.
- Aquatic diversity/abundance--wetlands support fisheries and aquatic invertebrates.
- Wildlife diversity/abundance--wetlands provide habitat for wildlife.

Adamus and Stockwell (1983) include two items they call "values" which also provide benefits to society:

- Recreation--wetlands provide areas for fishing, birdwatching, etc.
- Uniqueness/heritage value--wetlands support rare and unique plants, animals, and plant communities.

"Values" are subject to societal perceptions, whereas "functions" are biological or physical processes that occur in wetlands, regardless of the value placed on them by society (National Research Council 1995). The actual value attached to any given function or value listed above depends on the needs and perceptions of society.

Wetland Functional Assessment

For this project, CNHP utilized a qualitative, descriptive functional assessment based on the best professional judgment of CNHP ecologists while incorporating some of the principles of the hydrogeomorphic (HGM) assessment method. Each wetland was classified according to CNHP's Wetland Classification (Carsey et al. 2001), the National Wetland Inventory Classification (Cowardin et al. 1979) and hydrogeomorphic (HGM) (Brinson 1993) classification systems and twelve categories (listed below) were used to assess each wetland. Using the HGM method, wetland functions are evaluated or compared only with respect to other wetlands in the same subclass, because different subclasses often perform very different functions. For example, a montane kettle pond may provide habitat for rare plant communities never found on a large river but provides little in the way of flood control, while wetlands along a major river perform important flood control functions but may not harbor rare plant species. Thus, the category, **Overall Functional Integrity**, was included in the functional assessment to provide the user of some indication of how a particular wetland is functioning in comparison to its natural capacity, as opposed to comparing it to different wetland types.

The functional assessment assigns to each of the functions a value rating of "low", "moderate", or "high". The following functions were evaluated for most of the sites profiled in this report:

- Overall functional integrity
- Flood attenuation and storage
- Sediment/shoreline stabilization
- Groundwater discharge/recharge
- Dynamic surface water storage
- Elemental cycling
- Removal of imported nutrients, toxicants, and sediments
- Habitat diversity
- General wildlife habitat
- General fish/aquatic habitat
- Production export/food chain support
- Uniqueness

Overall Functional Integrity
The overall functional integrity of each wetland is a rating indicating how a particular wetland is functioning in comparison to wetlands in its same hydrogeomorphic class and/or subclass (see discussion below). For example, mineral soil flats (salt meadows) do not typically function as high wildlife habitat but do have high capacity for storing surface/groundwater. Thus, a mineral soil flat that is given a low rating for General Wildlife Habitat, General Fish Habitat, and Production Export/Food Chain Support does not necessarily indicate that the wetland is not functioning to its capacity. These ratings may just reflect that mineral soil flats, because of their landscape position and soil chemistry, naturally perform fewer functions than a depressional wetland. However, this particular wetland may be functioning the 'best' that could be expected from a mineral soil flat. The Overall Functional Integrity rating would reflect this by giving this particular wetland a 'Functioning at Potential' rating, based on the best professional judgment of CNHP ecologists. In summary, a mineral soil flat wetland having more "low" ratings than a depressional wetland does not necessarily mean that it is functioning improperly. However, if this particular mineral soil flat was given an Overall Functional Integrity rating of 'Functioning Below Normal', then it could be assumed that the wetland is not functioning to the capacity that it should (relative to other mineral soil flat wetlands).

Flood Attenuation and Storage
Many wetlands have a high capacity to store or delay floodwaters that occur from peak flow, gradually recharging the adjacent groundwater table. Indicators of flood storage include: debris along streambank and in vegetation, low gradient, formation of sand and gravel bars, high density of small and large depressions, and dense vegetation. This field assesses the capability of the wetland to detain moving water from in-channel flow or overbank flow for a short duration when the flow is outside of its channel.

Sediment/Shoreline Stabilization
Shoreline anchoring is the stabilization of soil at the water's edge by roots and other plant parts. The vegetation dissipates the energy caused by fluctuations of water and prevents streambank erosion. The presence of woody vegetation and sedges in the understory are the best indicator of good sediment/shoreline anchoring.

Groundwater Discharge/Recharge
Groundwater recharge occurs when the water level in a wetland is higher than the surrounding water table resulting in the movement (usually downward) of surface water (e.g., floodwater retention). Groundwater discharge results when the land surface is lower than the surrounding water table, resulting in the movement (usually laterally or upward) of groundwater (e.g., springs, seeps, etc.). Groundwater movement can greatly influence some wetlands, whereas in others it may have minimal effect (Carter and Novitzki 1988).

Both groundwater discharge and recharge are difficult to estimate without intensive data collection. Wetland characteristics that may indicate groundwater recharge are: porous underlying strata, irregularly shaped wetland, dense vegetation, and presence of a constricted outlet. Indicators of groundwater discharge are the presence of seeps and springs and wet slopes with no obvious water source.

Dynamic Surface Water Storage
Dynamic surface water storage refers to the potential of the wetland to capture water from precipitation and upland surface (sheetflow). Sheetflow is nonchannelized flow that usually occurs during and immediately following rainfall or a spring thaw. Wetlands can also receive surface inflow from seasonal or episodic pulses of floodwaters from adjacent streams and rivers that may otherwise not be hydrologically connected with a particular wetland (Mitsch and Gosselink 1993). Spring thaw

and/or rainfall can also create a time-lagged increase in groundwater flow. Wetlands providing dynamic surface water storage are capable of releasing these episodic pulses of water at a slow, stable rate thus alleviating short term flooding from such events. This function is applicable to wetlands that are not subject to flooding from in-channel or overbank flow (see Flood Storage and Attenuation). Indicators of potential surface water storage include flooding frequency, density of woody vegetation (particular those species with many small stems), coarse woody debris, surface roughness, and size of the wetland.

Elemental Cycling

The cycling of nutrients, or the abiotic and biotic processes that convert elements from one form to another, is a fundamental ecosystem process that maintains a balance between living biomass and detrital stocks (Brinson et al. 1985). Disrupting nutrient cycles could cause an imbalance between the two, resulting in one factor limiting the other. Thus, impacts to aboveground primary productivity or disturbances to the soil, which may cause a shift in nutrient cycling rates, could change soil fertility, alter plant species composition, and affect potential habitat functions. Indicators of wetlands with intact nutrient cycling need to be considered relative to wetlands within the same hydrogeomorphic class/subclass. Such indicators include high aboveground primary productivity and high quantities of detritus, within the range expected for that particular hydrogeomorphic class of wetlands.

Removal of Imported Nutrients, Toxicants, and Sediments

Nutrient retention/removal is the storing and/or transformation of nutrients within the sediment or vegetation. Inorganic nutrients can be transformed into an organic form and/or converted to another inorganic form via microbial respiration and redox reactions. For example, denitrification, which is a process that is mediated by microbial respiration, results in the transformation of nitrate (NO_3^-) to nitrous oxide (N_2O) and/or molecular nitrogen (N_2). Nutrient retention/removal may help protect water quality by retaining or transforming nutrients before they are carried downstream or are transported to underlying aquifers. Particular attention is focused on processes involving nitrogen and phosphorus, as these nutrients are usually of greatest importance to wetland systems (Kadlec and Kadlec 1979). Nutrient storage may be for long-term (greater than 5 years) as in peatlands or depressional marshes or short-term (30 days to 5 years) as in riverine wetlands. Some indicators of nutrient retention include: high sediment trapping, organic matter accumulation, presence of free-floating, emergent, and submerged vegetation, and permanently or semi-permanently flooded areas.

Sediment and toxicant trapping is the process by which suspended solids and chemical contaminants are retained and deposited within the wetland. Deposition of sediments can ultimately lead to removal of toxicants through burial, chemical break down, or temporary assimilation into plant tissues (Boto and Patrick 1979). Most vegetated wetlands are excellent sediment traps, at least in the short term. Wetland characteristics indicating this function include: dense vegetation, deposits of mud or organic matter, gentle sloping gradient, and location next to beaver dams or human-made detention ponds/lakes.

Habitat Diversity

Habitat diversity refers to the number of Cowardin wetland classes present at each site. Thus, a site with emergent, scrub/shrub, and forested wetland habitat would have high habitat diversity. The presence of open water in these areas also increases the habitat diversity at a site.

General Wildlife and Fish Habitat

Habitat includes those physical and chemical factors that affect the metabolism, attachment, and predator avoidance of the adult or larval forms of fish, and the food and cover needs of wildlife. Wetland characteristics indicating good fish habitat include: deep, open, non-acidic water, no barriers to migration, well mixed (high oxygen content) water, and highly vegetated. Wetland characteristics

indicating good wildlife habitat is: good edge ratio, islands, high plant diversity, and a sinuous and irregular basin.

Production Export/Food Chain Support

Production export refers to the flushing of relatively large amounts of organic material (both particulate and dissolved organic carbon and detritus) from the wetland to downstream ecosystems. Production export emphasizes the production of organic substances within the wetland and the utilization of these substances by fish, aquatic invertebrates, and microbes. Food chain support is the direct or indirect use of nutrients, carbon, and even plant species (which provide cover and food for many invertebrates) by organisms that inhabit or periodically use wetland ecosystems. Indicators of wetlands that provide downstream food chain support are: an outlet, seasonally flooded hydrological regime, overhanging vegetation, and dense and diverse vegetation composition and structure.

Uniqueness

This value expresses the general uniqueness of the wetland in terms of relative abundance of similar sites occurring in the same watershed, size, geomorphic position, peat accumulation, mature forested areas, and the replacement potential.

Hydrogeomorphic (HGM) Approach to Wetland Functional Assessment

In an effort to provide a more consistent and logical basis for regulatory decisions about wetlands, a new approach to assessing wetland functions--the *hydrogeomorphic* approach is being developed. In Colorado, the hydrogeomorphic, or HGM, approach to wetland function assessment is being developed by the Colorado Geological Survey, with help from the U.S. Army Corps of Engineers, other government agencies, academic institutions, the Colorado Natural Heritage Program, and representatives from private consulting firms (Colorado Geological Survey et al. 1998).

This approach is based on a classification of wetlands according to their hydrology (water source and direction of flow) and geomorphology (landscape position and shape of the wetland) called "hydrogeomorphic" classification (Brinson 1993). There are four hydrogeomorphic classes present in Colorado: riverine, slope, depression, and mineral soil flats (Table 1). Within a geographic region, HGM wetland classes are further subdivided into subclasses. A subclass includes all those wetlands that have essentially the same characteristics and perform the same functions.

One of the fundamental goals of HGM is to create a system whereby every wetland is evaluated according to the same standard. In the past, wetland functional assessments typically were on a site-by-site basis, with little ability to compare functions or assessments between sites. HGM allows for consistency, first through the use of a widely applicable classification, then through the use of *reference wetlands*. Reference wetlands are chosen to encompass the known variation of a subclass of wetlands. A subset of reference wetlands is a *reference standard*, wetlands that correspond to the highest level of functioning of the ecosystem across a suite of functions (Brinson and Rheinhardt 1996).

HGM assumes that the highest, sustainable functional capacity is achieved in wetland ecosystems and landscapes that have not been subject to long-term anthropogenic disturbance. Under these conditions, the structural components and physical, chemical, and biological processes in the wetland and surrounding landscape are assumed to be at a dynamic equilibrium that allows maximum ecological function (Smith et al. 1995). If a wetland is to be designated a reference standard for a given subclass of wetlands, it must meet these criteria. The need to locate reference wetlands is compatible with CNHP's efforts to identify those wetlands with the highest biological significance, in that the least disturbed wetlands will often be those with the highest biological significance.

Table XVII. Hydrogeomorphic Wetland Classes in Colorado (Cooper 1998 as cited in Colorado Geological Survey et al. 1998).

Class	**Geomorphic setting**	**Water Source**	**Water Movement**	**Subclass**	**Examples**
Riverine	In riparian areas along rivers and streams	Overbank flow from channel	One-directional and horizontal (downstream)	R1-steep gradient, low order streams R2-moderate gradient, low to middle order R3-middle elevation, moderate gradient along small/mid-order stream R4-low elevation canyons or plateaus R5-low elev. Floodplains	Herbaceous subalpine plant community. Willow shrublands along a montane creek Yampa River in Dinosaur N.M. Timpas River at the Arkansas River
Slope	At the base of slopes, e.g., along the base of the foothills; also, places where porous bedrock overlying a non-porous bedrock intercepts the ground surface.	Groundwater	One-directional, horizontal (to the surface from groundwater)	S1-alpine and subalpine fens on non-calcareous substrates. S2-subalpine and montane fens on calcareous substrates S3-wet meadows at middle elev. S4-low elevation meadows	Big Meadows in Rocky Mtn. N.P. High Creek Fen in Park County Wet meadows Plains wet meadows
Depressional	In depressions cause by glacial action (in the mountains) and oxbow ponds within floodplains. Lake, reservoir, and pond margins are also included.	Precipitation and shallow groundwater	Generally two-directional, vertical: flowing into and out of the wetland in the bottom and sides of the depression	D1-mid to high elevation basins with peat soils or lake fringe without peat D2-low elevation basins that are permanently or semi-permanently flooded D3-low elevation basin with seasonal flooding D4-low elevation basins that are temporarily flooded D5-low elevation basins that are intermittently flooded	Kettle ponds Cattail wetlands on Arkansas River Mishak Lake in San Luis Valley Abandoned beaver ponds. Playa lakes.
Mineral Soil Flat	Topographically flat wetland	Precipitation and groundwater	Two directional	F1-low elevation with seasonal high water table	Greasewood flats

Appendix XII. BEOL Field notes